# MANAGING INTERRUPTIONS:
# THE ROLE OF FIT BETWEEN TASK DEMANDS AND CAPACITY

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Interruptions are important phenomena in organizations, and researchers debate their effects on performance. This paper reviews the literature and argues that the degree of fit between task demands and an actor's capacity determines whether the effects of interruptions on performance are positive or negative. The fit model hypothesizes that for actors working with a capacity deficit (i.e., their capacity scarcely meet the task demands), interruptions have detrimental effects on performance. Moreover, the greater the actors' capacity, the less negative their reactions to interruptions will be. Time diaries, surveys, and archival studies were conducted among 92 public school principals in an urban school district in the eastern United States. The results support the hypothesis on the main effects of interruptions and partially support the proposed moderating effects of individual effort. The contributions of this research and its implications for future work are discussed.

## TABLE OF CONTENTS

## LIST OF FIGURES

## LIST OF TABLES

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# 1. CHAPTER ONE: INTRODUCTION

Interruptions are generally defined as unexpected events that break the continuity of primary, or planned, tasks (Jett & George, 2003). A review of the consequences of interruptions indicates that interruptions are inevitable phenomena in organizational life, and they can be significant in various aspects. Whereas conventional wisdom emphasizes the negative side of interruptions, the literature also identifies their positive effects on performance. Some researchers suggest that interruptions bring challenges as well as opportunities to organizations (e.g., Yakura, 2002). On the one hand, these unforeseeable events prevent the smooth implementation of the actors' plans. On the other hand, they force actors to improve their flexibility. Interestingly, studies confirming the latter argument have mainly been conducted at the group level. This paper observes both the positive and negative effects of interruptions and investigates the following research question: *What are the factors that determine whether the influence of interruptions is positive or negative?*

This paper makes the following efforts in order to answer the research question. First, this paper reviews the literature and develops a theoretical framework that highlights the distinctive effects of interruptions at both the individual and the group levels. The studies at the group level are intriguing and complementary to the findings at the individual level. With a focus on individuals' reactions to interruptions, this paper benefits from studies at both levels in its theory development. Specifically, at the individual level, although task complexity is found to moderate the impact of interruptions, research on coping strategies generally emphasizes the negative influence of interruptions (e.g., Kirmeyer, 1988). At the group level, positive signs were identified, and interruptions were sometimes encouraged, as groups were able to enjoy knowledge enrichment through the interruption process (e.g., Okhuysen & Eisenhardt, 2002; Staudenmayer, Tyre, & Perlow, 2002). By contrasting the findings from the two levels, the literature review examines the interruption phenomena from a new perspective and provides rich insights for the theoretical model.

Second, based on the theoretical framework, this paper suggests that the key factor that explains the inconsistent effects of interruptions is the degree of fit between task demands and the organizational actor's capacity. By the term "organizational actor" or "actor," I refer to the individual or group that encounters the interruptions. The fit model argues that neither task demands nor an actor's capacity can solely determine the effects of interruptions. Rather, it is the degree of fit between these two that influences performance. Following the logic that the degree of fit is positively related to performance, I focus on individual level phenomena, explore the factors that can determine the degree of fit, and predict the effects of fit on the relation between interruptions and job outcomes. The degree of fit is determined by the following: (1) factors that determine the demands of interruptions, including frequency, duration, clusteredness, and complexity of interruptions; (2) environmental factors that constrain an individual actor's capacity, including environmental challenges and environmental turbulence; and (3) personal factors that influence an individual actor's capacity, including individual experience and individual effort. I empirically tested the hypotheses on these effects.

Finally, this paper contributes to the literature by collecting time diary data among public school principals. Due to the challenge of data collection in the real world, a large proportion of previous studies were conducted in the lab context. The innovative method of using PDAs to record daily activities made it feasible to investigate a relatively large number of interruptions in the principals' work life. Findings based on the data set thus have strong implications to managers as well as knowledge workers.

In the following paper, I first review the literature and construct a theoretical framework focusing on the consequences of interruptions. Next, I propose the fit model and develop a set of hypotheses to address the research question. The hypotheses are tested in an empirical study, which is based on data collected from various sources, such as time diaries, surveys, and archives. I end the paper with a discussion of the implications for future research on interruptions.

# 2. CHAPTER TWO: LITERATURE REVIEW

In this section, I review the research on interruptions by contrasting the different effects at the individual and the group levels and provide possible explanations on the cross-level difference. Although the empirical study here is conducted at the individual level, this paper benefits from the group level findings in constructing its research model. Figure 1 details the process and outcome effects of interruptions at the individual and the group levels, respectively. A table summarizing the important empirical findings on interruptions is provided in Appendix A.

[Insert Figure 1 about here]

## 2.1 DEFINITION OF INTERRUPTIONS

Interruptions are generally defined as unexpected and uncontrollable events that break the continuity of the actor's primary tasks (Jett & George, 2003; McFarlane, 2002; Speier, Valacich, & Vessey, 1999; Staudenmayer, Tyre, & Perlow, 2002). In many experiments, interruptions are designed to be insertions that do not affect the completion of the primary tasks. That is, actors eventually get back to the primary tasks after they are interrupted (e.g., Edwards & Gronlund, 1998; Speier, Valacich, & Vessey, 1999; Speier, Vessey, & Valacich, 2003). However, in real work life, actors do not always return to the interrupted tasks. Therefore, field studies identify interruptions only based on their consequence of discontinuing on-going tasks but do not require observations of returning to those tasks (e.g., Chisholm, Collison, Nelson, & Cordell, 2000;

Flynn et al., 1999; Kirmeyer, 1988). This paper uses the definition that is commonly agreed on by researchers and does not emphasize on the completion of the interrupted tasks.

Although interruptions are common phenomena in organizations, research on interruptions is limited. The original investigation on interruptions dates back to Zeigarnik (1927), who found that individuals remembered interrupted tasks better than they remembered completed ones. However, research on interruptions surged only in recent years (e.g., Edwards & Gronlund, 1998; Fisher, 1998; Flynn et al., 1999; Kirmeyer, 1988; Okhuysen, 2001; Okhuysen & Eisenhardt, 2002; Oldham, Kulik, & Stepina, 1991; Perlow, 1997, 1999; Speier et al., 1999; Zellmer-Bruhn, 2003; Zijlstra, Roe, Leronora, & Krediet, 1999).

Empirical studies have developed various operationalizations of interruptions. Despite the different interpretations on the content of interruptions, most studies agree on two points in the definition of interruptions: that interruptions are unplanned events, and that interruptions occur during ongoing primary tasks. Meanwhile, the content of interruptions can be broad and involve events such as intrusions by a telephone call (Kirmeyer, 1988), the discovery of inconsistencies between expectations and information updates that lead to concern about a primary task (Jett et al., 2003), and pop-up windows during an online decision-making task (Xia & Sudharshan, 2002).

In the following, I discuss the distinctive consequences of interruptions at the individual and the group levels. Generally, the literature has observed more diverse interruptions to groups than to individuals. However, the effects of interruptions on performance at the group level tend to be more positive than those at the individual level.

## 2.2 CONSEQUENCES OF INTERRUPTIONS

Interruptions produce different results at the individual and the group levels. At the individual level, interruptions increase performance on simple tasks and decrease performance on complex tasks (e.g., Flynn et al., 1999; McFarlane, 2002; Speier et al., 1999; Zijlstra et al., 1999), whereas at the group level, most empirical work suggests that interruptions improve collective knowledge and performance (e.g., Mintzberg, 1990; Okhuysen, 2001; Okhuysen et al., 2002). An intuitive question is why individuals do not benefit from interruptions as much as groups do, and why groups appear to be immune to some of the negative effects of interruptions from which individuals suffer. In this section, I discuss the process effects and the job outcomes of interruptions as well as the corresponding contingency factors at the two levels. Furthermore, I offer answers regarding the question on the seemingly incompatible results at different levels.

Figure 1 details the model of the consequences of interruptions. Specifically, at the individual level, interruptions challenge people by increasing time pressure, information processing load, and demand for working memory. Work outcomes are moderated by task complexity, whereby performance is improved for simple tasks and impeded for complex tasks. In contrast, at the group level, it appears that interruptions induce processes of knowledge management. Job outcomes are found to be positive due to enhanced results of learning and innovation.

### 2.2.1 Individual Level Effects

Process effects at the individual level. First, interruptions demand extra time and force the primary task to be pushed behind, creating time pressure to finish the primary task. The literature on decision-making under time pressure suggests that people react to increasing time pressure by speeding up information processing. When speed cannot be increased anymore, they tend to analyze information in a shallow manner. As time pressure further increases, a simple analytical strategy will be adopted. Meanwhile, some people may become so upset that they give up on the task altogether (Edland & Sevenson, 1993).

Second, it is argued that interruptions increase the information processing load to the actor. People have limited information processing capacity (Simon, 1979). Similar to the reactions to time pressure, when the aggregated information cues from both the primary task and the interruption task exceed the limit of the capacity, information overload occurs (Milford & Paerry, 1977). People tend to cope with the tension by using simpler or inferior information processing strategies, which may have negative effects.

Finally, interruptions require effort to restore and retrieve information from memory because people need to remember the point at which the primary task was stopped so they may get back to that point to continue. People are likely to suffer from memory loss as interruptions occupy the working memory and cause forgetting on primary tasks. The memory literature has shown that interruptions that involve secondary tasks induce more severe forgetting on the intended action on the primary tasks than mere short-term delays (Einstein, McDaniel, Williford, Pagan, & Dismukes, 2003). Moreover, interruptions may break the flow that people are experiencing and thus reduce creativeness on the primary tasks (Mainemelis, 2001). Furthermore, the forgetting resulted from interruptions not only leads to loss of valuable ideas, but also requires extra time for memory recovery (Jett et al., 2003).

In summary, when an individual encounters interruptions, he/she is likely to experience increased time pressure, additional information load, and the potential of memory loss.

Job outcomes for simple tasks at the individual level. The literature does not provide definitions for simple and complex tasks on a quantitative base. Although Campbell (1988) describes complex tasks as involving multiple paths in solution, multiple outcomes and uncertainty, there is no clear suggestion for how to operationalize the constructs. Researchers such as Speier et al. (1999) operationally define simple task as those involving only information acquisition behavior and simple calculations. They do not explain complex tasks in the absolute terms, but they indicate that complex tasks require significantly more information processing than simple tasks. Other authors try to contrast simple and complex tasks by manipulating the attention required by the tasks. For example, Fisher (1998) uses a repetitive manual assembly task as a simple task and an in-basket for the job of an advertising manager as a complex task. In general, there is a tendency to describe simple tasks as repetitive, involving few information cues, and with low need for analysis. Complex tasks are loosely defined as the opposite of simple tasks.

The effect of interruptions on performance is moderated by the complexity of the primary task. When the primary task is simple and does not occupy all the capacity of human cognition, secondary tasks can be processed at the same time as the primary task without necessarily affecting the performance of the primary task. For example, Homans (1954), in his classic study, described that a group of cash posters (i.e., bank clerks whose major task was to attach notes on corresponding tapes of bills) who constantly chatted with each other could maintain a fast working speed. While most of them claimed that chatting during work was enjoyable, their performance seemed unaffected by the conversations.

Sometimes people may even improve their work efficiency when dealing with increased information cues (Shick, Gorden, & Haka, 1990). For example, Zijlstra et al. (1999) found that office workers who encountered interruptions from phone calls outperformed those who were not interrupted. This finding is paralleled by the observation of Speier et al. (1999), who found that participants who worked on simple decision-making tasks increased their decision accuracy and reduced the time used on the primary task when encountering interruptions. Therefore, the additional time pressure and information load brought by interruptions might serve as stimuli for high efficiency rather than burdens that challenge individual capacity.

A plausible explanation for the positive results on simple task performance is that interruptions enhance motivation without challenging individual capacity. Simple tasks can be boring and lacking challenging components (Fisher, 1998). People thus tend to pay just enough attention to finish the job. The certainty of being able to accomplish the task leads to a relaxed work pace, and boredom can result in carelessness that reduces work quality. Interruptions increase time pressure and information load, both of which alert the individual by demanding for further cognitive effort. This change urges individuals to reassess the task demands and raise cognitive awareness to the primary task (Speier et al., 1999; Zijlstra et al., 1999). Therefore, interruptions enhance the salience of simple primary task so individuals are motivated to concentrate on it.

The interruptions in prior empirical studies tend to be simple, so the extra workload created by the interruptions is not big enough to challenge individual capacity. Hence, the boosted motivation and the adequate capacity jointly result in improved performance. This seems to be true in spite of the contents of the primary task and the interruptions. For example, Speier, Vessey, & Valacich (2003) used simple-spatial tasks to interrupt either simple-spatial or simple-symbolic primary tasks. Performance of both types of primary tasks improved in the interruption group. In summary, interruptions bring additional time pressure and information load, which stimulate cognition awareness and reduce boredom due to the simplicity of the primary task.

The literature does not explain whether or how memory loss facilitates the positive effects of interruptions on simple tasks. However, there are at least three reasons to suggest that individuals doing simple tasks may avoid the negative effects of memory loss. First, the memory assigned for the simple primary task is limited (Speier et al., 1999). As a result, the demands of interruptions tend to be less intrusive because a relatively large amount of memory is available for them. Second, the information needed for a simple primary task is easy to re-learn even if it is forgotten during the interruption. Third, experience saves working memory because it allows people to perform simple tasks with little cognitive effort. Simple tasks are often repetitive without many deviations in the process. People thus have the chance to accumulate their experience in a short time. Such experience can be embedded in actions, which are triggered by signals in the process rather than being motivated by conscientious analysis and decisions (Weick & Roberts, 1993). As routines are established and stored in a process, working memory is freed to deal with interruptions. Moreover, when individuals return to the primary tasks after being interrupted, the reconsideration of the old routines is likely to increase heedfulness in actions, which in turn improve the quality of performance.

<u>Job outcomes for complex tasks at the individual level.</u> In contrast to simple tasks, complex tasks challenge the limits of human capacity. Interruptions compete with the primary tasks for the individual's attention. Time pressure becomes significant, and information overload occurs (Malhotra, 1982). Memory loss of important information becomes inevitable. Consequently, the quality of performance is likely to decrease (Hwang & Lin, 1999; Malhotra, 1984). Kirmeyer (1988) found that radio dispatchers at police stations suffered from the tension of information overload when they experiencing intense interruptions. Flynn et al. (1999) reported that pharmacists tended to make more errors in filling prescriptions when the frequency

of interruptions increased. Similarly, Speier et al. (1999) found that interruptions significantly reduced decision accuracy in complex tasks such as facility location and aggregate planning. Furthermore, motivation and satisfaction are negatively affected by interruptions as well (Baldacchino, Armistead, & Parker, 2002; Jacoby, 1984). In summary, performance is impeded and psychological cost is increased for complex primary tasks because interruptions compete with the primary task for resources.

The literature elaborates the negative effect of interruptions on complex task outcomes. The three process effects mentioned above, increased time pressure, information load, and memory loss lead to negative job outcomes when the primary task is complex. First, both time pressure and information overload are likely to increase rigidity in problem-solving strategies and hence decrease the accuracy of performance (Johnson, Payne, & Bettman, 1993). Furthermore, chances for self feedback and error correction are lost, leading to potential deficiency (Bruner, Goodnow, & Austing, 1956). An extreme case in Weick et al. (1993) illustrates the potential damage of interruptive events. A petty officer on an aircraft carrier lost a leg because his rhythm in work was interrupted by the frequently changing orders so that he failed to tie the aircraft down before moving underneath the plane to disarm, remove, and replace the ordnance (Weick et al., 1993). Thus, interruptions in complex tasks tend to increase the chance of making mistakes.

Second, long work hours are a common consequence of information overload (Laird, Laird, & Fruehling, 1983). Long work time can be undesirable because it breaks the psychological contracts and leads to less time for recreation and family responsibilities (Drago, 2001; Perlow, 1998). Whereas employees typically assume a forty-hour work week (Drago, 2000), their work time is frequently consumed by interruptions, which makes the original deadlines too close to finish the planned tasks in the assumed contractual time (Perlow, 1998). As a result, not only do employees sacrifice their personal time for work, organizations are forced to postpone deadlines to incorporate the demands of unexpected events or give employees overtime pay to compensate them for the extra hours (Yakura, 2002).

Finally, in addition to performance decreases and long work hours, people under stress are also likely to experience negative psychological reactions to interruptions (Blount & Janicik, 2001). Complex tasks demand full attention from individuals so that painstaking analysis and evaluation can be undertaken. Individuals who are occupied by complex tasks are likely to feel annoyed by interruptions because they understand that once they pause in their thinking, valuable intermediate results will be lost and their previous effort might be wasted. Moreover, if the individuals are fully concentrated in the primary tasks, they may have been enjoying the stage of flow (Mainemelis, 2001). They are likely to feel unhappy when interruptions end their joyful experience and remind them of the workload increase. Consistent with those arguments, Oldham et al. (1991) found that job satisfaction decreased when people perceived many stimuli in their working environment. Similarly, Xia et al. (2002) suggested that people are less satisfied with their decision-making process when they are interrupted in the middle.

In summary, the process effects of interruptions are likely to result in negative job outcomes when the primary task is complex. The accuracy of performance may be reduced because of inferior problem-solving strategies that are selected under stress. Work time may increase as a result of the extra time consumed by the interruption tasks and the necessary memory recovery for the primary tasks. The individual’s psychological state may also be negatively affected as people perceive pressure and uncertainty from interruptions.

### 2.2.2 The Group Level Effects

Many studies at the group level analyze interruption effects through the lens of knowledge management. It is maintained that interruptions bring opportunities to groups for information exchange and knowledge acquisition (Zellmer-Bruhn, 2003). Such process effects lead to collective learning, which increases group performance and group flexibility. Up to now, research in this stream has not investigated potential contingency factors of the effects. However, isolated case studies in relevant contexts can be found to indicate the potential negative reactions from groups. I will discuss the advantages and potential restrictions of groups at the end of the review section.

Process effects at the group level. Interruptions are likely to trigger information sharing among group members. Groups tend to discuss only the information held by all members and do not make much effort to share individually held information (Gigone & Hastie, 1993). Interruptions force groups to temporarily break from the common knowledge confirmation process and provide chances to reveal unshared information. Okhuysen and colleagues (Okhuysen, 2001; Okhuysen et al., 2002) found that interruptions brought up by members, such as reminders of deadlines and jokes, helped groups switch their attention from the ongoing discussion and identify additional unique information.

Second, it is found that interruptions facilitate knowledge integration. Zellmer-Bruhn (2003) surveyed ninety operational teams in the pharmaceutical and medical product industry. He found that frequency of interruptions (e.g., organizational structural change) increased the teams' effort of knowledge transfer as well as actual adoption of new practices from other teams. Okhuysen et al. (2002) instructed their participants to put emphasis on information sharing, questioning others, and time management during the group discussion. The instructions stimulated self-introduced interruptions, which facilitated the group's acquisition of knowledge owned by individual members and its combination of such knowledge in the decision-making process. Therefore, when properly guided, interruptions trigger the need to search for more external and internal information to improve group performance.

Finally, interruptions stimulate resource reallocation. Interruptions change the pace and rhythm of people's work and requirements for re-entrainment among group members (Ancona & Chee-Leong, 1996). The adjustment is likely to challenge the routines of previous operations and make resource reallocation plausible. For example, Kotter (1982) suggested that executives used unscheduled informal interactions to enhance employees' commitment and get things done through those people. Similarly, Meyer (1982) reported that top management teams at hospitals reacted to a doctor strike by reallocating monetary and human resources.

<u>Job outcomes at the group level.</u> First, interruptions promote adaptive learning through knowledge acquisition and resource reallocation. This can be explained by the concept of collective mind (i.e., "a pattern of heedful interrelations of actions in a social system," Weick et al., 1993:357). Weick et al. (1993) suggested that the heedfulness of collective mind is maintained by continuously interrelating individual behaviors through thoughtful coordination and knowledge explication. The more heedful the collective mind is, the more reliable the group performance, in spite of changes in task demands. Interruptions increase the heedfulness of collective mind. For example, Weick et al. (1993) argued that interruptions such as questions from newcomers are positive because old-timers can explicate and review the knowledge embedded in routines in an effort to answer the questions. In line with this reasoning, Staudenmayer et al. (2002) investigated interruptions with different scopes in the operations of three organizations, including cases such as a product line shutting down for a machine upgrades

and management's decisions to adjust the product development process. They found that interruptions forced daily work into a halt and left temporal spaces for the organizational members to reflect and make enhancements to their practices. Thus, as people crystallized the interrelations among actions, the collective mind was refreshed and prepared for further challenges.

Second, interruptions stimulate innovation through information exchange and knowledge acquisition. For example, Hargadon & Sutton (1997) conducted an in-depth investigation in a design company. They found that the company supported the process of collective innovations by exposing its employees to constant flows of new problems and frequently arranging for personnel outside the project teams to attend team discussions. These interruptions boosted innovation by introducing different perspectives and skills into the mindset of the teams.

Third, interruptions are likely to improve group performance in terms of quality and structural flexibility. For example, Meyer (1982) observed that top management teams who altered administrative practices during an employee strike either maintained or enhanced their performance through the experience. Okhuysen (2001) found that groups were able to accommodate small changes and effective adaptations during interruptions so their performance improved. Similarly, Staudenmayer et al. (2002) observed that teams capitalized on operation interruptions by reconsidering the interrupted projects and rearranging their approach toward superior performance.

In summary, studies at the group level suggest that interruptions can create opportunities to acquire and reconstruct internal and external knowledge. This keeps the groups flexible and adaptive, stimulates innovation, and enhances the quality of performance. However, since these investigations involve limited cases of interruptions, the findings may not be generalized to all groups and/or all kinds of interruptions.

### 2.2.3 Distinctive Effects of Interruptions at the Individual and the Group Levels

Compared to individuals, groups seem to react to interruptions more favorably. However, the literature does not explain why the negative results at the individual level are uncommon at the group level. Several explanations might be offered. First, groups are likely to be more resistant to time pressure than individuals because groups experience pluritemporal time (Nowotny, 1992; Yakura, 2002). As a task is segmented into smaller parts, many group members proceed with each part simultaneously. In contrast, individuals do not have the luxury to do that unless the task is very simple. Moreover, task distribution requires groups to decompose their tasks. Effective decomposition reduces the complexity of a task so that each member is able to finish his or her task components in a relatively short time (Simon, 1962). Hence, groups may have more time resources than individuals.

Second, groups seem to have larger information processing capacities than individuals. Mechanisms such as organizational memory (Walsh et al., 1991) and transactive memory (Moreland & Argote, 2003) ensure that individual capacity on information processing can be pooled together. Thus, information is sorted and processed by corresponding experts as well as by the coordinated actions (e.g., Weick et al., 1993). These mechanisms reduce the possibility of wasted capacity in redundant functions. Hence, groups are able to process more information than individuals can.

Third, groups can be more flexible than individuals because group communication helps members to explicate the rationale of behaviors and to maintain the sense-making process, which makes groups more heedful than individuals in routine work (Weick et al., 1993). When their capacity is challenged, individuals tend to close the feedback loop to concentrate on the chosen strategy, which is often suboptimal. This leads to rigidity in strategies because new information cannot go through cognitive process and trigger reactive behavior (Edland et al., 1993). In contrast, groups have to sustain interactions in order to coordinate. Through active communication, groups can diagnose changing situations and provide corresponding solutions. In fact, the more efficient the group communication, the more adaptive the group would be. Waller (1999) investigated flight crews' reaction to interruptions (e.g., unexpected requirements from air traffic control, hydraulic failure, and alteration in flying destination) in a flight simulation. She found that both the frequency of interactions and the speed of task reprioritization and redistribution after interruptions facilitated group performance. Thus, to respond properly to an interruption, the actor has to make sense of the event. Those who skip the stage of sense-making are likely to end up with inferior performance (Perlow, Okhuysen, & Repenning, 2002).

Fourth, groups can leverage resources so pressures on individuals can be shared by other members. As suggested above, groups can remove extra resources from one part of a task and reallocate them to another part so that the pressure of a bottleneck task is eased. For example, Waller (1999) reported that flight crews redistributed members' tasks when encountering interruptive events. Perlow (1999) documents a diary recorded by a software engineer who often described interruptions as being a "waste of time" to himself but beneficial to other colleagues. By focusing on the primary tasks and neglecting the organizational context, the individual level studies fail to capture the process of resource reallocation among tasks and people.

In summary, groups absorb the individual costs of interruptions by pooling resources of time and information processing capacity, by reacting with flexibility on task process strategies, and by members helping one another.

Having said so, it is important to note a limitation of groups. Although not investigated in the literature yet, it is reasonable to maintain that the results of interruptions at the group level depend on coordination among group members. If a group is not well coordinated, resources can be wasted in task redundancy, experts can be abused, and processes can become rigid. Cases of group failures are significant. For example, Perlow et al. (2002) describe the decision-making processes in an internet start-up. Driven by the belief that the faster the better, the management team tried to speed up the decision-making process at all costs. Consequently, although some members expressed concerns about the decisions, their voices were not loud enough to open the window of opportunity. The board blocked discussions on reasonable concerns and refused to switch its attention from its proposed option. Inefficient group interactions led to inferior decisions. The company finally chose an unpromising buyer, which went bankrupt soon afterward.

The findings at the group level suggest that sufficient group capacity contributes to the positive reactions to interruptions. It is thus plausible that an individual actor's performance in an interruptive environment also depends on his/her capacity. The next chapter develops this idea in detail.

# 3. CHAPTER THREE: THE FIT MODEL

The literature suggests that interruptions may have both positive and negative impacts on performance. However, no one has provided an overarching theory that explains the phenomena of interruptions across the individual and the group levels. In this chapter, I propose that the degree of fit between the task demands and an actor's capacity determines the effects of interruptions on performance. This model not only clarifies the reasons for the inconsistent findings on the effects of interruptions, but also demonstrates directions in which new contingency factors can be explored.

Next, I illustrate the fit model and how the degree of fit can be used to predict the effects of interruptions. I then elaborate its application at the individual level and conduct an empirical study to test the application. I will further argue for its implications at the group level in the chapter of discussion and implications.

## 3.1 DEGREE OF FIT BETWEEN DEMANDS AND CAPACITY

This paper proposes that the effects of interruptions are determined by the degree of fit between the task demands and the organizational actor's capacity. The contingency effects of the degree of fit are as follows. When both the task demands and the actor's capacity are high, or when both are low, the degree of fit is high, and so is the level of performance. In contrast, when the task demands are high but the actor's capacity is low (i.e., capacity deficit), or when the task demands are low but the actor's capacity is high (i.e., capacity surplus), the degree of fit is low, and the performance is inferior.

The studies on interruptions at the individual level maintain that the demands of the primary tasks (e.g., task complexity) determine the impact of interruptions on performance (i.e., Speier et al., 1999). However, research at the group level often suggests positive linear effects of interruptions, even though the primary task is quite complex (e.g., Okhuysen et al., 2002). The fit model can be generalized to both the individual and the group levels and explains the seemingly inconsistent results in the previous literature. It suggests that task demands are meaningful only when they are compared against the actor's capacity. Hence, performance will be superior when the total demands of the primary tasks and the interruptions are similar to the actor's capacity. In the following, I first explain the benefit of a high degree of fit and then discuss the two types of low degree of fit (capacity deficit and capacity surplus) and explain why both conditions lead to inferior performance. Furthermore, I apply the fit model on the individual level and examine the impacts of interruptions on the conditions of capacity surplus and capacity deficit, respectively.

### 3.1.1 High Degree of Fit

When capacity exactly meets the demands, performance should be higher than it is in the situations of either capacity deficit or capacity surplus situations. This is because the resources are not only abundant for the task accomplishment, but also lean enough so that nothing will be wasted. Examples of high degree of fit can be found in a few studies. At the individual level, Speier et al. (2003) suggested that tasks with thirty information cues and eighteen calculations are complex enough to keep individual capacity on the edge. Even simple interruptions to such tasks should result in capacity deficit and reduced performance. In contrast, tasks with two to eight cues and one to four calculations are simple enough to make a capacity surplus available for processing additional simple interruptions. Similarly, at the group level, Hansen (1999) observed knowledge searching and transfer among work groups in an organization. He found that weak intergroup relations fit better for searching task than strong intergroup ties because weak ties were enough to support superficial information exchange, whereas strong ties were wasted for such a simple task. On the other hand, strong intergroup ties outperformed weak ones in transfer tasks because intense communication and coordination were needed in knowledge transfer, and only strong ties were able to sustain the necessary interactions. In other words, knowledge searching tasks found a high degree of fit in weak ties and capacity surplus in strong ties, whereas knowledge transfer tasks found a high degree of fit in strong ties and a capacity deficit in weak ties. A high degree of fit should result in better performance than a capacity deficit or a capacity surplus.

### 3.1.2 Capacity Surplus

Capacity surplus occurs when demands are significantly below capacity. Despite the abundance of resources, capacity surplus does not mean superior performance. At the individual level, people may experience boredom when a task is not challenging at all (Fisher, 1998). They are unlikely to be motivated to pursue excellence because accomplishing the task does not fulfill their need for achievement. They are not eager to finish the work because it can be finished in time whether they try hard or not. Indeed, people may have the desire to avoid the boring work by taking breaks (Roy, 1960). Moreover, capacity surplus may lead to low job satisfaction (Zijlstra et al., 1999). This tends to further reduce people's concern about task performance.

At the group level, capacity surplus may lead to a waste of resources and rigidity of structure. First, people naturally have social interactions even if the tasks do not require such connections (Roethlisberger & Dickson, 1936). Thus, if the tasks do not require intense interaction and coordination among group members, the maintenance work will be wasted, and the well-maintained relations might be used to facilitate irrelevant processes. Therefore, the maintenance of the interactions not only fails to enhance the task performance, but also distracts members' attention from the tasks. Furthermore, both knowledge management and social capital perspectives suggest that communication and coordination among group members is likely to be more efficient as people practice more (Adler & Kwon, 2002; Argote & Insko, 1995). If the task demands do not meet the level of the group's capacity, the group will lose the chance to gain the know-how on coordination activities. There will be a lack of opportunities to crystallize the knowledge embedded in the cooperation process on various tasks. Creativity is likely to be negatively affected because the demands of the tasks limit the occasions that knowledge from various areas is required, retrieved, or combined (Nonaka, 1994).

### 3.1.3 Capacity Deficit

In contrast to the condition of a capacity surplus, a capacity deficit occurs when demands exceed capacity. Capacity deficit leads to inferior performance because the actor is incompetent to accomplish the task. At the individual level, capacity deficit may result in simplified information processing (Edland et al., 1993), low-quality decision-making (Speier et al., 1999), and insufficient implementation (Flynn et al., 1999). As interruptions increase, people become anxious, and fear that they may not be able to finish their planned tasks (Perlow, 1999). Under the time pressure, they tend to sacrifice the quality of their performance in order to accomplish the assigned task (Edland et al., 1993). As a result, they make more errors and the performance accuracy drops (Flynn et al., 1999). Their creativity is also reduced because they lose the ability to concentrate on the task and fail to link the immediate work with other relevant knowledge they have (Amabile, Hardley, & Kramer, 2002).

At the group level, capacity deficit may prevent people from cooperating effectively. Interruptions bring unscheduled tasks to groups and force them to react without rehearsal. The total task demands increase not only in terms of sheer workload, but also as a reflection of the need for improvisation in operations. The group cannot rely on established routines to cooperate on the unscheduled tasks. To generate an instant response to interruptions, new information needs to be collected and analyzed, additional decisions need to be made, and more solutions need to be implemented on top of the primary tasks.

If the group is already on the edge with the primary tasks, interruptions will jeopardize group performance because the available capacity cannot sustain the additional demands of extra workload and improvisation. First, important signals can be ignored as the occupied communication channels no longer support information sharing. For instance, Perlow et al. (2002) reported that management groups tend to dismiss objections quickly because they want to skip the stage of evaluating options and save time for implementation. Closing the windows of opportunity is inevitable when capacity is insufficient because groups tend to assign higher priority to actions than learning. It is also risky because reduced information analysis leads to immature decisions that are inferior to those made following adequate analysis.

Second, no capacity is left for re-entrainment. Unscheduled tasks tend to change the pace of each member's actions in idiosyncratic ways. This enhances the need for groups to re-entrain the paces of their behaviors (Ancona et al., 1996). Therefore, the uncertainty brought by the interruptions reduces the reliability of members' expectations of each other and requires comprehensive information sharing. However, people under pressure are likely to simplify their strategies and depend on the interaction manner they find the most comfortable. As a result, communication is insufficient, and group members make individual changes on their own part of the work while assuming that others are making corresponding adjustments. The interpretation of the situation is left to different assumptions unshared within the group, and the inconsistency in role expectations is unlikely to be clarified until errors occur (Weick, 1990).

Thus, at both the individual and the group levels, both types of low degree of fit (capacity surplus and capacity deficit) undermine performance. In the context of interruptions, the degree of fit is changing because interruptions bring more demands to the actors (e.g., Simon, 1962; Weick, 1990). Figure 2 illustrates the change induced by interruptions. Without interruptions, there is an original degree of fit between the primary task demands and the actor's capacity. Then, when the interruptions occur, the demands increase. Holding the capacity constant, interruptions either reduce capacity surplus (i.e., improve the degree of fit) or increase capacity deficit (i.e., reduce the degree of fit). Therefore, interruptions enhance the degree of fit only on one side (i.e., when the original degree of fit is capacity surplus) and decrease the degree of fit in other cases (i.e., when the original degree of fit is high, at Point J, or is capacity deficit). Consequently, interruptions improve performance when the original degree of fit is capacity surplus and impede performance when the original degree of fit is high or is capacity deficit.

[Insert Figure 2 about here]

Next, I use the notion of capacity deficit and capacity surplus to analyze the effects of interruptions at the individual level.

## 3.2 APPLICATIONS OF THE FIT MODEL AT THE INDIVIDUAL LEVEL

In the above, I suggest that a high degree of fit between task demands and an actor's capacity leads to superior performance, and both capacity surplus and capacity deficit are unfavorable in terms of performance. Interruptions increase the total demands of tasks. In the case of capacity surplus, increases in demands reduce the gap between demands and capacity and leads to a higher degree of fit. However, for those with capacity deficit, the surge in demands stretches the already restricted capacity and lowers the degree of fit. Therefore, interruptions produce distinct results for capacity surplus and capacity deficit conditions.

### 3.2.1 Reactions to Interruptions When an Individual Has a Capacity Surplus

Reduced capacity surplus is desirable and can be achieved by introducing interruptions. First, an actor is likely to feel bored because his/her task is not challenging enough. Interruptions imply to the actor that the work waiting to be done is more than what was planned. This requires more effort toward the accomplishment of the tasks and reduces boredom. Second, a capacity surplus leaves extra capacity aside, which requires maintenance. Some work needs to be assigned to occupy the extra capacity so distracting thoughts are at least oriented and do not affect the performance of the planned tasks. Oldham, Commings, Mischel, Schmidtke, & Zhou (1995) did a quasi-experiment among a group of office workers whose job included invoice processing, account analysis, etc. They compared the workers who listened to music while working on the primary tasks with those who did not have background music. They found that working with the distraction of music enhanced productivity. Interruptions have similar effects to distractions in such situations. Discontinuing a boring task will make it fresh later on, after the extra capacity has been consumed.

Moreover, the literature on social facilitation maintains that the presence of others leads an actor engage in behaviors with which he or she is most familiar rather than actions that need much thinking (Zajonc, 1965). This is useful for non-challenging tasks because the actor tends to be familiar with the process of such work. Comparatively, the social facilitation effect seems to be less helpful for demanding tasks, such as complex problem solving, which require innovative thinking. Because many interruptions in the workplace are induced by peers, they are likely to bring the effects of social facilitation and benefit the performance of those who have a capacity surplus.

### 3.2.2 Reactions to Interruptions When an Individual Has a Capacity Deficit

An increase in capacity deficit is troublesome, and interruptions can trigger such a change. First, interruptions produce an additional information load on the actor. When an actor's attention is fully occupied by the planned tasks, interruptions lead to information overload. As the actor becomes unable to process all the information, he/she would need to either cut off the information inflow and base his/her solutions on the processed information, or change his/her strategy so it allows a shallow understanding of the situation. This results in noncomprehensive decisions and low-quality performance.

Second, interruptions limit the range of an actor's consideration and lead to bias in decisions on resource allocation. Many interruptions occur as emergencies and need immediate care. Being involved in such emergencies creates a tendency to rush toward the completion of current tasks. While fully concentrating on each task, an actor may lose sight of the whole picture, where the priorities of some planned tasks should be updated as events occur. Failure to adjust the schedule can result in unreasonable allocation of resources and inferior outcomes of implementation.

Third, interruptions may cause bypass of routines as a coping method to save energy. Many daily tasks are processed with routines, which ensure stable performance with high quality. Because routines involve tacit knowledge accumulated through experience, they are usually followed without the explication of reasoning. When interruptions put an actor into a deep capacity deficit, he/she is motivated to take short cuts and save resources on the task processes. Routines can be vulnerable in such cases because the actor is not able to quickly tell how meaningful they are. Under pressure for speed, an actor can make wrong decisions to get rid of seemingly useless routines, not knowing how much this would affect the results of the current tasks as well as other potentially related tasks. Therefore, interruptions encourage individuals in capacity deficit to take opportunities to eliminate task routines and negatively impact the job outcomes.

Finally, interruptions deprive actors of resources and result in negative feelings due to low expectation of achievement. People feel a loss of control when interruptions interfere with their plans. They may not be able to obtain high quality in their work because of insufficient capacity, and their need for achievement is not satisfied. When planned tasks are forced to be cancelled, actors may lose confidence in their ability. Otherwise, if the actor attributes his/her deficiency to interruptions, he/she may view the work environment as unsupportive and his/her job satisfaction may drop.

Following the above discussion, my arguments in the next chapter focus on the condition of individual capacity deficit. I explore the effects of interruptions on performance and identify the moderators that can alter the effects of interruptions. The application of the fit model at the group level will be elaborated in the section of discussion and implications.

# 4. CHAPTER FOUR: HYPOTHESES DEVELOPMENT

As explained above, all the hypotheses developed in this chapter are based on the precondition that an actor is experiencing capacity deficit. That is, the task demands tend to exceed the actor's capacity, so the actor needs to struggle to finish the planned daily tasks. In such a situation, interruptions are likely to have a primarily negative effect on daily performance. Furthermore, the abundance and stability of internal and external resources determines an actor's potential capacity, which interacts with the main effect of interruptions.

## 4.1 INDICATORS OF INTERRUPTIONS

The fit model suggests that, when individuals experience a capacity deficit, an increase in the demands of interruptions leads to a decrease in performance. The demands of interruptions can be captured from at least four standpoints: duration, frequency, clusteredness (explained below), and complexity. Next, I will discuss how these aspects reflect the demands of interruptions and thus influence performance.

### 4.1.1 Frequency of Interruptions

When an individual is experiencing a capacity deficit, an increased frequency of interruptions negatively affects performance. First, when an actor is frequently interrupted, he/she has to alternate working memory between the planned tasks and the unplanned tasks. For each interruption, the actor needs to at least partially unload his/her working memory to deal with the interruptions. The unloading process can be complex because, ideally, not all information is lost. The information needs to be filtered so the most important clues are remembered and/or marked as the references for later recovery. If the clues are not properly stored, the actor will have to relearn the information when it is time to resume the interrupted tasks. Unfortunately, interruptions occur unexpectedly, and many of them need immediate attention. The result is that actors react to interruptions before they have time to store their working memory of the on-going tasks. As the interruptions invade the working memory, information is given up un-selectively. For those who are already using all their resources to handle the planned tasks (capacity deficit), loss of useful information during interruptions (additional demands) is inevitable. Even if fragments of the memory remain, they are likely to be disorganized and need significant work before they make sense again. This not only leads to longer recovery time, but also affects the quality of performance when some parts of the memory are unrecoverable.

Einstein, McDaniel, Williford, Pagan, & Dismukes (2003) conducted an experiment to see how fast people forget their intentions on planned tasks after they are briefly interrupted. They first created a demanding situation in which the participants were kept busy with several tasks. Next, they asked the participants to press the slash key after a 40-second delay when they saw a red screen appear on the computer monitor. They found that participants forgot to press the slash key more often when an interruption task was introduced during the delay than when the delay was not interrupted. Hence, even brief interruptions cause memory loss and affect performance on planned tasks.

Second, frequent interruptions prevent an actor from entering or staying in the flow. Flow is a psychological state that an individual experiences when he/she is fully involved in a task and loses self-consciousness and a sense of time (Mainemelis, 2001). Flow is desirable because it indicates a superior combination of resources. Flow is often credited for leading to higher productivity, better quality work, more creativity, higher motivation, and higher job satisfaction than the common state of a work process (Mainemelis, 2001). According to the four-channel model in the flow literature, flow is in fact the demonstration of a high degree of fit between task demands and an actor's capacity (Massimini & Carli, 1988). When the task demands exceed an actor's capacity in general, falling into the flow for a certain task allows the individual to enjoy a high degree of fit at the micro level and temporarily forget other demanding tasks.

Flow ensures that capacity is used in the optimal way for the current work, and thus it results in superior performance of the task. However, it is unlikely for people to enter the flow if interruptions occur in the early stages of a planned task. On the other hand, interruptions that occur in the later stages of a planned task present an external force to stop the flow. Because flow is enjoyable, pulling people out of the flow can result in negative emotion. In addition, if the actor returns to the planned task after dealing with the interruption, it takes time to resume the flow on the rest of the task. If the later part of the task is important, there is likely to be a decline in performance as well as motivation.

Third, frequent interruptions bring a sense of uncertainty, which reduces the level of concentration on the on-going tasks. A large number of interruptions indicate that there are numerous factors that do not fall into the plan. They remind the actor that the situation is unpredictable. People do not like uncertainty because it restricts their control over their context. To remain in control, actors would update their plans to take future interruptions into consideration. They may refuse to concentrate on the planned tasks because diversified attention allows them to be alert for external signals, so they will not be surprised by interruptions.

Reducing an actor's attention to the planned tasks increases the existing capacity deficit, which is harmful to performance.

Finally, frequent interruptions keep people in a state of emergency, which alters their strategy in processing on-going tasks. When an actor makes a plan for the day, the plan is based on the resources he/she expects to have. For those whose capacity hardly meets the demands, plans tend to reserve few resources for unexpected events. When interruptions happen frequently, their precious resources are depleted from time to time. No matter how short the interruptions, the actor is likely to be annoyed when constantly halted from his/her planned tasks. Moreover, frequent interruptions may lead an actor to predict that work in the rest of the day is going to be interrupted often as well. Because actors cannot tell when they will be interrupted, they can develop a sense of urgency about finishing the planned task before the next interruption. In a condition of capacity deficit, completing a task in a hurry may be done at the cost of quality, or it may be simply impossible because the tasks are demanding. Perlow, Okhuysen, & Repenning (2002) illustrated a case in which the pressure of making quick decisions led to poor judgments and failure in business.

### 4.1.2 Duration of Interruptions

When an actor is experiencing a capacity deficit, the duration of interruptions negatively affects performance. First, long interruptions increase time pressure and alter the priority of performance criteria. Because the actor is experiencing capacity deficit, he/she tends to allocate a limited amount of time to each task and leave little slack time in between. Long interruptions consume more than the slack time in the plan and reduce the time available for planned tasks. This increases the salience of deadlines, and other performance criteria — such as quality — became relatively less important. The actor may consider alternative task processes in order to meet the deadlines. Although it is possible to improve efficiency by creating shortcuts between task elements, such smart innovation is unlikely under time pressure (Amabile, Hardley, & Kramer, 2002). Rather, it is often found that important information is ignored, a rigid strategy is used, and an inferior solution is adopted.

Second, long interruptions lead to increasing information loss about the primary task, reducing the smoothness of the day's plan. Forgetting is a function of time. The longer the time elapses, the more information is forgotten. Muter (1980) asked participants to do reading tasks and tested their memory on the tasks after a 2, 4, or 8-second interval. He found that the amount of information recalled diminished as time elapsed. Globerson, Levin, & Shtub (1989) observed similar results with participants who performed repetitive typing tasks. The intervals between two batches of tasks varied from one to eighty-two days. The performance of those participants demonstrated that forgetting became more severe as the interval between batches lengthened. Therefore, it is plausible to suggest that the longer an interruption, the more difficult it will be for the actor to recall information about the interrupted tasks. As a result, long interruptions increase the cost of the recovery on the interrupted tasks.

Third, people who experience long interruptions may be forced to cancel some planned tasks and potentially reduce their performance for the day. The interrupted tasks are especially vulnerable to plan adjustment. Because the interruptions take place during the planned tasks, they directly compete for time and other resources with the interrupted task. Dropping the interrupted task protects the time allotted for other tasks and prevents the negative impact of interruptions from extending to those tasks. Also, the effort needed to recover the working memory on the interrupted tasks can be demanding due to information loss over the long durations of interruptions. Cancellation of the unfinished planned tasks saves that effort and protects the performance of later tasks.

On the other hand, when the interrupted tasks are too important to be cancelled, people may adjust their plans and rearrange the tasks after the interruptions. They may do one of three things in the adjustments: reduce the time scheduled for some of the tasks, cancel some tasks, or work longer hours. For the first option, time pressure may affect task performance, as discussed above. For the second option, the quality of the overall performance can be reduced because less work is finished than was originally planned. For the third option, the plan is finished without sacrificing much quality in performance at the expense of increased time at work, but it may affect the individual actor's well-being because the extra work hours would otherwise have been used to deal with private issues.

### 4.1.3 Complexity of Interruptions

The complexity of interruptions determines how demanding they are. Increasing complexity has an increasingly negative impact on performance. According to Campbell (1988:43), complex tasks (as distinguished from simple tasks) are often ill-structured, ambiguous, and difficult. They are characterized by (1) multiple potential ways or paths to complete the task, (2) multiple desired outcomes, some of which may conflict with one another, and (3) uncertainty regarding whether the chosen path to complete the task will produce the desired outcomes.

First, complex interruptions encourage people to actively erase their working memory of the interrupted tasks. An interesting factor relevant to working memory is the effort in memorization. Muter (1980) ran three experiments in which he informed the participants of (1) only the reading tasks, (2) a small possibility of a memory test after the reading tasks, and (3) a certain memory test after the reading tasks. In fact, participants in all three experiments took the memory test. Whereas participants in all three experiments remembered less after longer intervals following the reading tasks, those who prepared for a certain memory test recalled much more information than those who did not expect the test. This indicates that working memory does not function automatically. Rather, people are able to adjust their effort in information retention according to the requirements of the task (Muter, 1980). Complex interruptions demand the full attention of the actor. Any reservation in the working memory may restrict the depth of information analysis and lead to inferior solutions. As the actor tries to completely concentrate on the interruptions, he/she is necessarily engaged in active forgetting of previously stored information. This creates difficulties in recovering the interrupted tasks. On the other hand, knowing that resuming the interrupted tasks requires retention of certain information, the actor may be reluctant to lose that information and move his/her focus to the interruptions. However, if an actor is only semi-focused on an interruption, he/she may not be able to think through the interruption thoroughly enough to solve the problem satisfactorily. Thus, no matter how the actor modifies his/her effort in memorization, there are potential negative implications on performance.

Second, because complex interruptions are ambiguous and result in potentially conflicting outcomes, the actor may not be able to assess the outcomes immediately after the problems are treated. Such uncertainty may lead an actor to continue to think about the way he/she handled the interruptions even after they are completed. Such self-reflection is a distraction to later tasks and may have consequences on the performance of those tasks.

In addition, complex interruptions may also bring more fatigue than simple interruptions, reducing an actor's ability to resume the interrupted tasks. Efficiency is likely to drop when people feel tired, and an actor will need a relatively longer time to pick up the interrupted tasks after finishing with the interruptions. If, having dealt with the interruption, the actor's energy only allows him/her to process simple tasks and the primary tasks happen to be complex, the actor will have difficulty accomplishing those tasks successfully.

### 4.1.4 Clusteredness of Interruptions

Temporally clustered interruptions (i.e., interruptions that occur close to one another in time) are likely to reduce the demands of interruptions compared with temporally scattered interruptions. If the number of interruptions in a certain period (e.g., one day) is fixed, the more interruptions are clustered, the fewer unexpected breaks in the primary tasks will occur in a day.

First, it is recognized that interruptions make actors switch their working memory back and forth between the ongoing work and the interruptions. The process of memory switching allows actors to retain information about the primary tasks in long-term memory, so people may remember how to continue on the job after the pause (Edwards et al., 1998). But the preparation stage for information storage and retrieval takes time. Therefore, it potentially increases the pressure to speed up the tasks at hand. If interruptions occur one at a time, the actor will have to stop the primary task and make a round of memory switches for each interruption. On the other hand, when multiple interruptions occur together, they share one break from the primary task and save further costs due to memory switches.

Second, compared with a scattered pattern, clustered interruptions leave larger time spaces between interruptions, which enable the actor to become more deeply involved in the primary tasks for a longer time. Ideally, actors may find themselves reaching a state of flow and having a good experience performing the tasks. In contrast, when interruptions are scattered, they break the primary tasks into smaller segments, none of which may be long enough to allow people to be fully engaged in the task.

Clusteredness reduces the demands of interruptions and thus leads to a reduced capacity deficit. Perlow (1999) reported an attempt to cluster interruptions by setting a quiet time for individual work. Interruptions from peers had to occur in non-quiet time, rather than at any time during the day. Presumably, interruptions are more likely to be clustered when they are inserted in a shorter time period. The knowledge workers reacted to the strategy positively. They believed that they got more things done in a shorter time, got better control over their work, and they were more satisfied with their jobs.

In summary, frequency, duration, complexity, and clusteredness of interruptions represent the demands of interruptions. When an actor is experiencing capacity deficit, frequency, duration, and complexity decrease performance, whereas clusteredness increases performance.

*Hypothesis 1: The demands of interruptions are indicated by (a) the frequency of the interruptions, (b) the duration of the interruptions, (c) the complexity of the interruptions, and (d) the clusteredness of the interruptions. For actors who experience capacity deficit, frequency, duration, and complexity of interruptions are negatively related to performance, whereas clusteredness of interruptions is positively related to performance.*

## 4.2 ENVIRONMENTAL FACTORS

An actor's capacity depends on both the internal and the external resources available to him/her. The internal resources are determined by the actor's personal characteristics, such as individual experience and individual effort, whereas the external resources are determined by the actor's task environment. Next, I discuss how the task environment affects an actor's capacity, which moderates the main effects of interruptions on performance. The arguments on the moderating effects of internal resources are elaborated next.

The literature suggests that the task environment in which an actor is working determines the quantity and quality of the resources that the actor can maneuver. Previous research has identified three dimensions of task environment: munificence, dynamism, and complexity (Aldrich, 1979; Castrogiovanni, 1991, 2002; Dess & Beard, 1984; Keats & Hitt, 1988). This paper is especially interested in the environmental constraints brought by the first two dimensions. In the following, environmental munificence is exchangeable with environmental challenge, and environmental dynamism is called environmental turbulence.

### 4.2.1 Environmental Challenge

Some work environments are more challenging than others because there are fewer resources available. Actors in challenging environments tend to have tight budgets. They have to use their resources with care and may not have the luxury to reserve slack resources to deal with unexpected tasks. When interruptions occur, actors in such environments do not have enough capacity to cope with the unexpected changes. If they alter the allocation of resources to process the interruptions, some planned tasks will suffer the opportunity cost of the resources. On the other hand, if they refuse to change the plan, the interruptions have to be neglected.

Environmental challenges constrain the number of alternatives available to deal with interruptions. Restricted resources make many options impossible. The actor does not have much choice but to tailor his/her strategy to fit the resources available. Moreover, task processes are likely to be uncreative because scarce resources do not allow exploration by trial and error. When interruptions occur in such circumstances, constraints become more salient, and solutions tend to be ineffective.

Interruptions in challenging environments are also likely to undermine an actor's motivation. When an actor makes a great effort to get his/her plan carried out, he/she may be too occupied to deal productively with interruptions. Seeing unexpected events ruin the plan is disappointing. The actor is likely to worry about the scarcity of resources, feel nervous about his/her incapability to do what is desired, and have little patience to deal with the interruptions along with the rest of his/her plan. The effect on performance is detrimental.

*Hypothesis 2: The demands of interruptions influence performance more negatively when environmental challenges are many than when they are few.*

### 4.2.2 Environmental Turbulence

Environmental turbulence refers to "the rate and unpredictability of changes in the organization's environment" (Danneels & Sehi, 2003: A3). It is different from interruptions in that it does not directly break into planned tasks in people's daily work. Environmental turbulence increases the demands of interruptions, reinforces capacity deficit, and amplifies the negative impact of interruptions on performance.

Compared with a stable environment, a turbulent environment demands prompt response to interruptions and requires comprehensive understanding of the interruptive events. First, environment turbulence increases the demands for capacity because interruptions in a dynamic environment require immediate attention. One of the strategies individuals use is to delay their reaction to interruptions (Coates, 1990). Delay allows individuals to continue working on the primary task with stable performance. It resists the increase in demands created by the overlap of the primary task and the interruption and gives the actor time to prepare for the task switch. The strategy of delay is useful as long as the interruption tasks remain the same during the delayed period. A dynamic environment, however, highlights the uncertainty of the future, which suggests that interruptions may change quickly. Therefore, processing an interruption in a timely manner is required because the demands of the interruptions may increase unproportionally if delayed. Processing interruptions promptly creates a lack of control over the timing of task switches. Actors cannot choose to stop the primary task at a preferred point and have no chance to organize the primary tasks before interruptions. Interruptions in a dynamic environment thus demand for more capacity than those in a stable environment because the high urgency requires immediate attention and induces time pressure and stress (McFarlane, 2002).

Second, interruptions in a dynamic environment require deeper analysis and more careful consideration than those in a stable environment. This is because environment turbulence increases uncertainty about the processing of tasks. It can be inefficient to treat similar interruptions in similar ways because the context is changing, and experience can become irrelevant (Argote et al., 1995). People need to understand the interruptions in the current context, identify the idiosyncrasy of the interruptions, and give specialized treatment to each interruption task. Besides, the uncertainty in a dynamic environment also makes it difficult to predict the results of interruption processes. This requires people to increase their effort to search for potential alternatives and evaluate the benefits and risks of the alternatives. Hence, the demands of interruptions are reinforced in a dynamic environment because people need to take the present context and future uncertainty into consideration.

*Hypothesis 3: The demands of interruptions influence performance more negatively when the working environment contains high turbulence than when the turbulence is low.*

## 4.3 INDIVIDUAL FACTORS

An actor's individual capacity can modify the relationship between interruption and performance in that it mitigates the problem of capacity deficit. The larger an individual's capacity, the more task demands that person can handle, and the less likely the person is to experience capacity deficit. Individual capacity is partially represented by individual experience and individual effort. Next, I discuss their effects separately.

### 4.3.1 Individual Experience

Individual experience affects an actor's ability to handle demanding tasks. Actors with more experience are likely to understand and solve interruptions in a more comprehensive way. People need to make sense of a problem by connecting it with related areas of knowledge (Lindsay & Norman, 1977). The knowledge accumulated through experience facilitates accurate evaluation of the relevance and importance of interruptions. Without such knowledge, people will fail to make sense of an interruption and are unable to identify an effective solution (Weick, 1996).

Second, the know-how gained through experience promotes improvisation and creative solutions. The literature maintains that experience enables people to recognize patterns of events and avoid getting lost in combinations of unrelated single events (Simon, 1981). The ability to identify interrelations among events narrows the range of alternatives that can be used to respond to interruptions (King & Ranft, 2001). This reduces the capacity invested in searching for alternatives and also allows an experience actor to pull knowledge from various areas together for improvisations tailored for particular interruptions.

Finally, accumulated prior knowledge enhances learning through interruptions. Memory about prior knowledge is self-reinforcing and allows people to connect new information with existing constructs (Bower & Hilgard, 1981). Moreover, more knowledgeable people tend to learn in more effective ways because their experience in acquiring knowledge enhances their learning ability (Cohen & Levinthal, 1990). Therefore, an actor's amount of prior knowledge facilitates interruption handling because it improves his/her understanding of events, enhances creativity in novel situations, and benefits individual learning.

*Hypothesis 4: The demands of interruptions influence performance less negatively when the actors have long experience than when their experience is limited.*

### 4.3.2 Individual Effort

The effort that an actor is able to invest in tasks is another indicator of individual capacity. Actors differ in their effort in terms of available hours for working. The number of hours one can invest in his/her work changes as the priority of work varies from person to person. Some people are unenthusiastic about their work and choose to allocate their spare time to develop hobbies, and others have obligations to families and have to leave for home at certain times (Drago, 1998; Perlow, 2000). Compared to these people, those who have more time to stay on the job are likely to deal with interruptions more effectively because they are less pressured and more flexible in task planning.

First, with less time pressure, actors are able to handle both the primary task and the interruptions in a heedful manner. People can avoid the tendency to fall into the "speed trap" (Perlow et al., 2002) and can be more careful in evaluating alternatives and implementing solutions. Furthermore, many interruptions are caused by organizational members asking for cooperation and help (Perlow, 1999). Having more time for work than other people suggests that an actor has a larger proportion of time working alone without being interrupted by colleagues. Such an actor can thus handle interruptions during the time when everyone is present and can process some of his/her planned work uninterrupted before or after normal hours. Therefore, the extra time that an individual puts into work not only releases the tension between demands and capacity, allowing high-quality strategies in processing interruptions, but also provides the alternative of scheduling the primary tasks strategically. Actors with extra time may arrange important planned tasks during hours when the context is not interruptive and might be generous in using the common work hours for interruptions.

*Hypothesis 5: The demands of interruptions influence performance less negatively when the actors make large effort at work than when they make small effort.*

In summary, when an actor is experiencing a capacity deficit in his/her daily work, the demands of interruptions negatively affect performance. Moreover, an increase in the actor's capacity enhances the degree of fit and promotes performance when there is a capacity deficit. Correspondingly, two sets of factors that alter an actor's capacity are proposed to moderate the main effect of interruptions. External factors that influence an actor's capacity are environmental challenges and environmental turbulence. Internal factors are individual experience and individual effort. Figure 3 illustrates the hypothesized relations among the variables.

[Insert Figure 3 about here]

# 5. METHODOLOGY

## 5.1 STUDY DESIGN

This paper uses time diaries to investigate interruptions. Previous studies have used experiments, activity questions, and participative observation to discover the characteristics of interruptions. Time diaries are preferred to other alternatives because they have the advantages of (1) investigating interruptions in organizational contexts, (2) collecting reliable and accurate records about the intensity and patterns of interruptions, and (3) addressing interruptions in a quantitative way.

First, time diaries are more appropriate than experiments for investigations on the dynamism of interruptions in organizational contexts. Experiments simplify the phenomenon because they usually design interruptions as simple events that take a very short time (e.g., Speier, Valacich, & Vessey, 1999). In fact, however, knowledge workers and managers often spend more than one third of their work time on complex interruptions (Perlow, 1999; Thomas & Ayres, 1998). Time diaries detail these activities over several days and document the diversity and complexity of interruptions. It is thus plausible to expect time diaries to reveal various interruptions that are not covered in experiments.

Second, time diaries are more reliable and accurate than activity questions. The questions applied in previous interruption research tend to be terse and therefore unable to address the richness of the events. For example, Hammer, Bauer, & Grandey (2003) measured the intensity of interruptions by asking participants to estimate the frequency of being disrupted during work time within the past month. It is possible that the participants would suffer from fading memory due to the passage of time. This memory deficiency not only distorts estimations of the frequency of events, but it also prevents the participants from retrieving further details beyond the frequency estimation. In comparison, time diaries require the participants to recall activities within 24 hours or shorter intervals (Juster, 1985a; Juster, 1985b). This method does not require the participant to estimate the frequency or duration of events from memory, but calculates the information from real-time records. It also ensures the accuracy and completeness of the recorded information because of the short time lags between the occurrences and information retrieval.

Third, time diaries are less costly than participative observation and can be used to collect information from a relatively large sample. Participative observation has been widely adopted to record the details of participants' daily activities. Carefully conducted research strives to minimize the observers' influence on the participants and often brings intriguing insight to the literature (e.g., Perlow, 1997). However, participative observation is expensive to implement on large samples. To collect data from a sample with a statistically meaningful size, one needs either to train multiple observers or to invest a significant amount of time to make observations alone. In this approach, however, reliability across observers or over a long time can become problematic. Unlike participative observation, time diaries do not require researchers to accompany the participants during observation, thus they make it possible to administer a relatively large sample simultaneously. In summary, time diaries are appropriate for the data collection in this paper because they provide an affordable approach that provides reliable data in an organizational context.

Besides using the time diaries to keep account of interruptions, this paper also uses separate surveys and organizational archives to measure other relevant variables.

## 5.2 RESEARCH SETTING

The data were collected among principals in an urban public school district in the eastern United States. There were 95 schools in the district, including 59 elementary schools and 36 middle, high, and special schools. Total student enrollment in the school district was approximately 38,000 students, and the district had a total of approximately 5,200 employees. The school principals were asked to keep time diaries during two week-long periods. Ninety-two principals provided their time diary data for at least one work day, accounting for 97% of all potential respondents.

Why School Principals? School principals are instructional leaders as well as middle managers in their school district. As the key people in the schools, principals have multiple responsibilities and tasks to deal with every day. The instructional leadership role includes tasks such as curriculum development, supervision of teaching, staff development for improved teaching, and teacher evaluation (Cawelti, 1987; Duke, 1987). Meanwhile, as the school managers, the principals have to act upon school discipline, schedule organization, school facilities management, employee supervision, etc. (Knezevich, 1975). The workloads of the principals are increasingly complex as school size increases (Chase & Kane, 1983). Whereas many principals use most of their on-the-job time on managerial tasks (Nelson, 1983), the current literature on education emphasizes the instructional leadership role, which is found to be essential to the success of principals (Cawelti, 1987; Malone & Caddell, 2000). Principals are aware of the significance of their instructional leadership role and are willing to spend more time on curriculum improvement, faculty development, and direct interactions with students than on administrative activities. However, they are occupied by administrative work and are unable to allocate enough time to instructional leadership tasks (Gooch, 2002). In general, the literature describes the principals' work as demanding, complex, and filled with role conflict.

This paper intends to investigate people who constantly encounter interruptions, and who usually experience capacity deficit at work. School principals were selected to be the participants because they satisfy both conditions. First, as the top decision makers in their schools, the principals spend a significant amount of time dealing with interruptions. Thomas et al. (1998) suggested that one third of principals' work time was consumed by interruptions. The constant flow of interruptions allows reliable measures on the focal interruption characteristics in the hypotheses.

In addition, school principals are among those whose capacity is challenged by the amount, diversity, and complexity of their work (Peterson, 1982, 2005). The nature of principals' work requires them to switch between the conflicting roles of instructional leader and administrator (MacCorkle, 2004; Malone & Caddell, 2000). Within each role, there are numerous responsibilities that the principals need to fulfill. As a result, principals often work extra hours and struggle to accomplish various tasks (Peterson, 1982). Thus, school principals experience capacity deficit, satisfying the prerequisite for the hypotheses.

## 5.3 PROCEDURES

Procedure of time diary data collection. The time diary method applied in this paper is a modification of the traditional implementation (see Leana & Pil, 2006). As indicated in the section of study design, it is proper to use time diaries to capture the characteristics of interruptions as well as planned activities. An instrument was constructed to guide the principals to keep diaries. First, the development of time-use categories went through three stages.

Initially, interviews were conducted among several focus groups of principals from urban districts around the U.S. The original time-use categories were formed from those data. Next, the technology of making entries according to the categories was pre-tested among the middle and top managers of the focal district to refine the categories. Finally, a second pretest of the refined categories was run on a sample of five principals.

The final instrument includes six categories, each of which contains a list of options that describe the types of the events in the category. The categories are (1) subject of the event, (2) with whom the principal worked during the event, (3) where the event happened, (4) how the principal worked on the event, (5) whether the event was planned or unplanned, and (6) whether the principal thought that the event was a good use of time (see Appendix B). During the discussions with the focus groups, it appeared that although the principals often multi-task, they could identify a primary activity or work focus during any specific time period. Therefore, the time diary entries are constructed as mutually exclusive.

Second, a software program was developed to enable the principals to record their daily activities on personal digital assistants (PDAs). Compared with traditional written time diaries, this innovation reduced the time and effort required for the diary keeping. With the PDAs, the principals could record diary entries by choosing the start and end-time of the events as well as appropriate items in each of the categories. For example, a principal might meet with a group of teachers from 11am to 12pm to discuss curriculum issues. This event could be recorded by choosing "11am" in the start time category, "12pm" in the end time category, "teacher(s)" in the with whom category, "face-to-face with a group" in the how category, "curriculum" in the subject category, and "other school facility" in the where category. The software also recorded the actual time when the entry was made. The PDA beeped every two hours to remind the principals to input information about the events just occurred. While the sound could be distractions to the principals, it was not designed to discontinue the principals' work. The data suggested that principals chose their time to make entries rather than immediately responding to the beep.

In March 2001, training sessions were held with all principals in the district on the use of the PDA time diary method. The school district was consulted, and two week-long periods were chosen when there were no unusual events in the district. The principals were asked to keep their time diary entries on the PDAs. Once all the data were collected and recorded, the PDAs were given to the principals for their personal use as a gift for participation in the study.

Procedures for collection of other data. A principal survey was conducted after the collection of time diary data. In the survey, principals were asked to estimate the reliability of the diary data and report their tenure in the principal position.

To learn the complexity of daily tasks, a separate survey was conducted among public school principals in a different school district. The responses were used as experts' opinions to assign a weighted complexity ratio to subjects of activities. Description of these data is reported in the section of measures.

Finally, archival data on the principals' task environment (e.g., environmental challenges and environmental turbulence) were collected from the district and state records.

## 5.4 MEASURES

The categories in the time diaries are listed in Appendix B, and example time diary entries can be found in Appendix C. Below is the detailed description on each measure of the study variables, followed by the explanation to a transformation of the performance measure.

Primary tasks vs. interruptions. In the time diaries, the principals were asked to record whether each activity was planned or unplanned. The planned activities were coded as the primary tasks, whereas the unplanned activities were coded as interruptions. Activities set as "No Value" were excluded.

Frequency of interruptions. This was measured by the number of unplanned events in each day. On average, principals experienced about 6 unplanned activities in a day (SD = 5.56).

Duration of interruptions. First, the duration of each unplanned event was added up for each day. This was divided by the number of unplanned events in the day to get the average duration of unplanned events for that day. The mean of the average duration of interruptions in a day was about 33 minutes (SD = 24.54).

Complexity of interruptions. The activities of the principals were categorized into three levels of complexity according to the subject category. The principals were asked to indicate the subject of each activity. There were 13 activity subjects listed on the PDA menu, such as issues on "instruction and curriculum" and activities in "facility management." Both planned and unplanned events were categorized into these thirteen subjects.

To assess the complexity of these subjects of activities, a survey was conducted among a group of public school principals for their expert opinions. The sample in this survey was independent from that of the time diary study. Based on the definition of complexity provided in the instructions of the survey (Campbell, 1988), thirty-six principals rated the complexity of the activity subjects. Intraclass correlation (.896) indicated excellent inter-rater reliability. The formula used to calculate the daily complexity score is as follows:

$$\text{Complexity} = \sum_{i=1}^{13} [(\text{number of unplanned events in Subject i}) \times (\text{complexity score of Subject i})] / (\text{total number of unplanned events})$$

The mean scores of the subjects were calculated, with "classroom observation" as the least complex subject and the principal's "personal development" as the most complex subject (see Table 1). The unplanned events of a day were grouped into the thirteen subjects, and the proportion of the number of unplanned events in each subject was multiplied by the mean scores of the subjects. The sum of the products of the above steps was used as the complexity score of the unplanned events in the day. The average complexity of interruptions in a day was 3.61 (SD = 1.10).

[Insert Table 1 about here]

Clusteredness of interruptions. The clusteredness is indicated by the Gini coefficient of the day's activities. Gini coefficient is a measure of inequality of a distribution, defined as the ratio of the area between the Lorenz curve of the distribution and the curve of the uniform distribution to the area under the uniform distribution. In this study, a Gini coefficient was used to measure the inequality of the distribution of interruptions during the day. It was calculated based on the following formula (Brown, 1994):

$$G = \left| 1 - \sum_{i=1}^{n} ( \sigma x_i - \sigma x_{i-1} ) ( \sigma y_i + \sigma y_{i-1} ) \right|,$$

Where G indicates Gini coefficient, $x_i$ indicates the proportion of the cumulative duration of events in the *i*th hour interval, and $y_i$ indicates the proportion of the cumulative number of events in the *i*th hour interval. Thus, a day was first divided into twenty-four one-hour intervals. The durations and number of unplanned events were coded within each interval. These durations and numbers were then aggregated, respectively. The results were used as the basis to calculate $x_i$ and $y_i$ in the formula.

Gini coefficient values fall between 0 and 1, where 0 corresponds to perfect equality and 1 corresponds to perfect inequality. If a principal was interrupted eight times in two one-hour intervals and was not bothered for the other six hours of the day, his/her Gini coefficient of the day would be higher than someone who encountered one interruption in every single hour of the day. Therefore, a high value of Gini coefficient means that the interruptions are clustered in a relatively short period of time. Furthermore, because both $x_i$ and $y_i$ are in the form of a proportion of the cumulative values, the effects of total work duration and the total number of interruptions are excluded. The average clusteredness of interruptions in a day was .35 (SD = .29).

Environmental challenge. The socioeconomics status of the student population in each school was used as a proxy for the level of environmental challenge to the school. It was measured by the proportion of students eligible for free or reduced-price lunch in the school. The average level of the environmental challenge was 64.59% (SD = 17.82%).

Environment turbulence. The environmental stability was measured by student mobility in each school. Frequent changes in the student population reduce the stability of the social climate in the school. The administration is forced to react promptly to help students adjust to their new social and physical contexts. Therefore, student mobility indicates the dynamism of the school environment. Although the schools were in the same district, variation in student mobility was high. On average, the level of environmental turbulence was 29.94% (*SD* = 22.76%).

Principals' individual experience. The principals' experience was indicated by the number of years they had been working as principal in their current school. It measured the accumulated career knowledge of the principals and indicated their ability to efficiently deal with the daily activities. Since the micro work environments differ from school to school, a measure on the tenure of principalship in the current school is preferred to the years of principalship across schools. (mean = 5.04 years, *SD* = 4.60).

Principals' individual effort. Individual effort was indicated by the principal's total work time in a day. Principals' daily work time was calculated from their time diaries by adding up the durations of recorded events in each day. Principals' average work time was about 9 hours per day (*SD* = 2.26 hours).

Performance. As the principals recorded the events they just encountered, they were required to evaluate whether dealing with the events was a good use of time. They were told to report their evaluation by choosing from "Yes — Good use of a principal's time", "No — Not a good use a principal's time", and "Unsure". The proportion of the duration of good use of time was used as a performance measure. The average daily performance was such that 86.93 percent of the total time was well used (SD = 17.05%).

The performance measure was the best available in the dataset. However, it was not ideal for the hypotheses testing. First, traditional measures for task performance tend to focus on effectiveness and efficiency rather than the use of time. Second, the yes/no/unsure scale seemed to be too general to detect the variance in performance. Thus, a Likert scale rating of 1 to 7 for the task performance would be more accurate than the yes/no assertion for the good use of time.

Transformation. Many principals provided time diary data for multiple days. Thus, each day's record may not be independent from that of the other days recorded by the same person. There are six measures constructed from the time diary data. These are: *performance — proportion of good use of time*; *frequency — number of unplanned events*; *duration — average duration of unplanned events*; *clusteredness — Gini coefficient of unplanned events*; *complexity — complexity of unplanned events*; and *individual effort — total duration of work time*. Among these measures, frequency, duration, complexity, clusteredness, and individual effort were calculated from objective records of the events. They should not be subject to the non-independent problem due to repeated data collection from one person. For example, if an event started at 9am and ended at 9:30am, all participants would make the same entries for the start time and end time as the event occurred. Individual differences should be ignored for measures derived from such data. In contrast, the measure of performance was subjective and may involve individual biases. Some participants might always rate their time use as good no matter what happened, while some others always give lower self-evaluations even if they did as well as other participants. To control the non-independent problem in the performance measure, a transformation was done by subtracting the mean score of performance across the days reported by one principal from the raw data.

## 5.5 MISSING DATA

Because the time diary data and other information were collected through distinct methods and at different times, the response rates varied. All ninety-two principals in the school district reported at least one work day's activities of time dairy. They produced 876 days of records in total. Among these principals, 46 principals with 445 days of records provided information on *individual experience*, 65 principals with 638 days provided information on *environmental turbulence — mobility rate*, 66 principals with 646 days provided information on *environmental challenge — socioeconomics status*, and all 92 with 876 days of records provided information on *environmental challenge — school level* and *individual effort – total work time*. For reports on correlations, missing data were excluded pairwise. In regression analysis, the interaction effects were tested in separate regression models, so each model was treated independently. Therefore, missing data were excluded listwise only within each model, resulting in different sample sizes for different models.

# 6. RESULTS

This chapter explains the results of the statistical analysis. First, exploratory factor analysis was performed on the four indicators (i.e., frequency, duration, complexity, and clusteredness) to determine the dimensions of the demands of interruptions. Based on the results of the factor analysis, hierarchical regression was used to test the hypotheses on the effects of interruptions and the moderating factors. Finally, post hoc analysis was performed to discover extended findings.

## 6.1 FACTOR ANALYSIS

The factor analysis was performed with SPSS using a variance maximizing (varimax) rotation of the original variable space to achieve maximum variance on the new axes. The factor analysis applied the Kaiser criterion and retained only factors with eigenvalues greater than 1. Two components were found to have eigenvalues larger than 1. Table 2 shows the rotated factor loadings on the two components. A close examination of the loadings suggests that the measures were not meaningfully loaded on the components. Except for the frequency of interruption, which cleanly loaded on the second component, all the other three measures loaded on both components. Because the explanatory power of the two components is limited, it is plausible to treat frequency, duration, complexity, and clusteredness as four distinct dimensions of interruptions.

[Insert Table 2 about here]

## 6.2 DESCRIPTIVE SUMMARY AND CORRELATIONS

The means, standard deviations, and zero-order correlations of the study variables are presented in Table 3. First, all four dimensions of the demands of interruptions were significantly correlated with the dependent variable. As predicted, frequency (number of unplanned events) (-.093, $p<.01$), duration (average duration of unplanned events) (-.147, $p<.01$), and complexity (-.139, $p<.01$) of interruptions were negatively correlated with performance (proportion of good use of time), whereas clusteredness (.102, $p<.01$) of interruptions was positively related to performance. This was consistent with Hypothesis 1.

[Insert Table 3 about here]

Second, the four dimensions were significantly correlated among themselves. Intuitively, frequency and duration are negatively correlated (–.203, $p<.01$), indicating that people spent less time on each interruption when the interruptions occurred more often. Complexity is positively correlated with duration (.293, $p<.01$), as more complex interruptions are likely to take longer to treat. In addition, clusteredness was negatively related to the other three measures.

Finally, none of the proposed moderating variables was significantly correlated with performance. Nevertheless, individual effort was positively related to frequency (.202, $p<.01$), duration (.098, $p<.01$), and complexity (.153, $p<.01$) of interruptions, and negatively related to clusteredness (–.148, $p<.01$). This implies that people might cope with higher demands of interruptions by putting in more effort. Also, individual experience was negatively correlated to duration of interruptions (–.121, $p<.05$), showing that experienced principals tended to process interruptions quickly. In addition, the two environmental factors were positively related with each other (.088, $p<.05$), and both were negatively related with individual experience. It seems that principals tended to remain in one school for a longer time when the environment was less challenging (–.270 $p<.01$) and less turbulent (–.251, $p<.01$).

## 6.3 HIERARCHICAL REGRESSION ANALYSIS

Aiken and West (1991) suggest that interaction terms tend to cause collinearity problems in regression analysis. They suggest two methods to solve such problems: the centered raw score analysis and the standardized analysis. The centered raw score analysis transforms data by subtracting the means of the independent and moderating variables from the raw data. Alternatively, the standardized analysis requires the researcher to take the standardized scores (z-scores) of all the variables involved in the regression model, including the dependent variable. One needs to take caution to (1) calculate the interaction terms as the product of the z-scores of the variables, not the standardized scores of the product of the raw data and (2) read the raw coefficient (unstandardized beta) in the regression model as the proper solution, which has the same value as the standardized coefficient in the centering analysis (Cohen, Aiken, & Cohen, 2002; Friedrich, 1982; Aiken, 1991). In this study, I used the standardized solution and calculated z-scores of all variables before the interaction terms were formed and entered into the regression analysis. The coefficients reported are the unstandardized betas, following the instructions of the authors cited above.

Hierarchical regression was used to test hypotheses on the moderating effects. Tables 4 to 7 show the results of the hierarchical regression analysis. Due to the reasons explained in the section about missing data, the sample size of each regression model varies. The last rows of each table indicate the corresponding sample sizes applied to the regression models. For each hypothesized moderating variable, the hierarchical regression analysis started with a base model involving only the independent variables (frequency, duration, complexity, and clusteredness of interruptions). A second model entered the moderating variable to the base model. The third model added the interaction terms between the independent variables and the moderating variable to the second model. The tables report the three models in each set of the hierarchical regression analysis, as well as the R-square changes in each model. Simple slope analysis was then performed to identify the directions of the moderating effects.

Hypothesis 2 suggests that environmental challenges tend to magnify the negative effects of interruptions on performance. The four independent variables and the interaction terms of environmental challenges were entered in models 1 to 3 in Table 4. As shown in the table, environmental challenge virtually did not have moderating effect on performance. Hence, Hypothesis 2 was not supported.

[Insert Table 4 about here]

Hypothesis 3 maintains that environmental turbulence amplifies the negative effects of interruptions on performance. To test this hypothesis, the interaction terms of environmental turbulence and the four independent variables were entered in regression models 4 to 6 in Table 5. The interaction with duration was significant (.217, $p<.01$). Other interaction terms were nonsignificant. According to Hypothesis 3, we should see that the main effects of interruptions become more negative when environmental turbulence increases. However, result of the simple slope analysis indicated that the direction of the significant interaction with duration was opposite to the prediction (see plot in Figure 4). Therefore, Hypothesis 3 was not supported.

[Insert Table 5 about here]

[Insert Figure 4 about here]

Hypothesis 4 argues that individual experience mitigates the negative effects of interruptions. This was tested through hierarchical regression, reported in models 7 to 9 in Table 6. None of the interaction terms were significant. Thus, Hypothesis 4 was not supported.

[Insert Table 6 about here]

Hypothesis 5 predicts that individual effort makes the main effects of interruptions less severe. The test results are shown in models 10 to 12 in Table 7. Consistent with the hypothesis, the interactions with complexity (.078, $p<.05$) and with clusteredness (.087, $p<.05$) were positively related to performance (see plots in Figure 5 and Figure 6). However, interactions with frequency and duration were not significant. Thus, Hypothesis 5 was partially supported.

[Insert Table 7 about here]

[Insert Figure 5 about here]

[Insert Figure 6 about here]

Model 10 in Table 7 allow us to further address the main effects of the four dimensions of demands of interruptions, which are predicted in Hypothesis 1. According to Hypothesis 1, interruptions that occur frequently, take a long time, and have complex content tend to jeopardize performance for people with a capacity deficit. On the other hands, these actors would benefit from temporally clustered interruptions because they need to make fewer switches from the "interruption mode" to the "planned task mode." The correlation table (Table 3) shows that frequency, duration, and complexity were significantly negatively related to performance, whereas clusteredness was significantly positively related to performance. These results supported Hypothesis 1. In the hierarchical regression models, however, not all the measures remained significant. The change of the effects may be due to the inter-relations among the four measures. Model 10 tests the main effects in the full sample (n=876). Specifically, frequency (–

.110, $p<.01$) and duration (–.150, $p<.01$) of interruptions were significantly negatively related to performance, whereas the effects of complexity and clusteredness became nonsignificant. It appears that the effects of frequency and duration were more robust than those of complexity and clusteredness. Table 8 summarizes the results of the hypotheses testing.

[Insert Table 8 about here]

## 6.4 POST HOC ANALYSIS – THE EFFECTS OF SCHOOL LEVELS

It is plausible that school level captured some differences in the work environment beyond the two measured environmental features, challenge and turbulence. Therefore, post hoc analysis was conducted to test the potential moderating effect of the environmental factor reflected by school levels. First, a categorical variable of school levels (0 = elementary school; 1 = other-level school) was developed and entered in the correlation table (Table 3). It appeared that, compared with elementary school principals, middle, high, and special (these are referred to as "other-level" in the paper) school principals experienced more frequent (.082, $p<.05$) and less complex (-.097, $p<.01$) interruptions, faced a less challenging (measured by percentage of students eligible for free or reduced lunch; –.119, $p<.01$) but more turbulent (measured by student mobility rate; .228, $p<.01$) environment. Moreover, principals in other-level schools had shorter tenure (–.141, $p<.01$) but work longer hours (.098, $p<.01$) than those in elementary schools. Next, the variable of school levels and its interaction terms with the four measures of interruptions were entered in the hierarchical regression models.

[Insert Table 9 about here]

Models 13 to 15 in Table 9 report the results of the analysis on the effects of school levels. From model 15, we can tell that the moderating effects of school levels were generally significant but not in consistent directions. First, the interaction with frequency was positive and significant (.089, p<.05), meaning that the negative main effect of frequency was more severe in the other-level schools than in the elementary schools. Second, the interaction with duration was positive and significant (.142, p<.01), indicating that the significant negative effect of duration was attenuated more in the other-level schools than in the elementary school. Finally, the interaction with complexity was negative and significant (–.098, p<.05), suggesting that the effect of complexity altered from nonsignificant in the elementary schools to negative in the other- level schools.

Because the differences between school levels were significant, I re-ran tests on the moderators' effects with the sub-samples of elementary schools and of other-level schools, respectively. However, the results did not reveal any more supporting evidence to the hypotheses than that derived from the full sample. Therefore, although the work lives of the principals tended to be different across school levels, the differences did not seem to be reflected in the effects of interruptions.

# 7. DISCUSSIONS AND CONCLUSION

This paper investigates the effects of interruptions, especially at the individual level. It is suggested that interruptions are not independent from other phenomena. Rather, the effects of interruptions depend on the fit between the actor's capacity and the demands of the overall tasks. Other things being equal, three groups of factors are proposed to determine the relation between interruptions and performance. These are the demands of the interruptions, the capacity of the individual actor, and environmental factors.

This final chapter includes a brief discussion of the results of the hypotheses tests and post hoc analysis. It then analyzes the contributions and weaknesses of the study, and summarizes its implications to research and practice. Finally, the chapter provides suggestions to future research and closes with an overall conclusion.

## 7.1 DISCUSSION OF RESULTS

This study develops a fit model and tests its predictions on the effects of interruptions on individuals who tend to experience a capacity deficit in their daily work. The results provided partial support to the hypotheses. The main effects of all four dimensions of the demands of interruptions were significant. Also, individual effort generated partial effects. However, tests of environmental challenge, environmental turbulence, and individual experience failed to produce supporting evidence.

First, it was maintained that individual performance decreased when demands of interruptions increase. The study measures the demands of interruptions by frequency, duration, complexity, and clusteredness. Previous literature is limited in the investigation of the demands of interruptions. Although it was intuitive to use frequency and duration to measure interruptions, few studies examine the significance of the content and temporal pattern of the incidents. Findings from this study suggested that, consistent with the hypothesis, all four dimensions significantly contributed to changes in performance. It appeared that the principals performed worse when they encountered frequent, long, or complex interruptions. Meanwhile, they made better use of their time when the interruptions were temporally clustered rather than temporally scattered.

Next, two environmental factors were introduced as moderators. It was argued that the more challenging and turbulent the work environment, the more likely an individual was to experience capacity deficit and perform poorly. The data did not support this prediction. The harmful effects of environmental turbulence and environmental turbulence were not detected. On the other hand, the significant result of the interaction between environmental turbulence and duration appeared opposite to the hypotheses, suggesting that a turbulent work environment helped people to react less negatively to long interruptions. This may be due to the possibility that the principals managed to take advantage of long interruptions to deal with the unstable environment. It is possible that the principals took various environmental factors into consideration during relatively long interruptions. Such activities may satisfy the need of achievement, which results in better self-evaluation of performance on the interruption tasks. Furthermore, long interruptions may bring useful information that could help improve performance for the rest of the day.

In addition to the environmental factors, it was also hypothesized that individuals can increase their capacity to reduce the negative effects of interruptions. Specifically, the more experience an individual had and the more effort the individual invested in work, the less negative the effects of interruptions on performance. Results suggested that individual experience did not make any difference on the effect of interruptions. One plausible explanation for the lack of finding is that there is a ceiling effect in learning to cope with daily interruptions. That is, principals might be able to develop strategies in dealing with daily interruptions in a relatively short period. The strategies may not improve significantly once they were established. So, no matter how long the principals had served in their positions, their performance in handling interruption tasks through the day remained the same. An alternative explanation is that the interruptions were so unpredictable that they require improvisation all the time. As a result, experience in the position could not help the principals develop strategies for future interruptions. It is unlikely that all the daily interruptions were one-shot games and would not repeat in the future. However, because the principals experienced capacity deficit, they tended to have few resources to review the way they handled the interruptions and make improvements for reoccurrence of the same kind of interruptions.

Test on the effects of individual effort provided partial support to the fit model. Although more individual effort did not relieve the negative influence of frequent and long interruptions, it appeared that individual effort influenced the effects of interruptions on the dimensions of complexity and clusteredness. The detrimental effects of complex interruptions were weakened because of abundant time resources. Although small effort could be enough to produce satisfactory solutions for simple interruptions, large effort was necessary to process complex interruptions effectively. Thus, when the individual enhanced his/her capacity by increasing his/her effort, he/she was more likely to have thorough analysis and make quality decisions on complex problems. In other words, individual effort alleviated the negative effects of complex interruptions because the more complex the interruptions, the more sensitive they were to the restrictions of individual effort.

Besides the effects with complexity, individual effort also had a positive effect with clusteredness. It seemed that when the time resources was limited, clustered pattern of interruptions could not produce long enough intervals that allowed the individual to concentrate on the planned tasks. Therefore, no matter how the interruptions were clustered, principals who spent relatively short time on work might not be able to take advantage of such temporal pattern and improve their performance. To realize the benefit of the clusteredness, individuals need to invest long work time so that patient and careful treatments to their tasks become possible.

The overall weak support for the fit model raises the question on whether there are alternative mechanisms that better explain the interruption phenomena. One potential theory that calls for further investigation is the drive theory in the social facilitation literature. According to the drive theory (Zajonc, 1965), the mere presence of others is associated with arousal, which makes people perform better on simple tasks but worse on complex tasks. Similar to the presence of others, interruptions might be a source of arousal, especially when considering the fact that many workplace interruptions are induced by co-workers and thus involve the presence of the co-workers. Therefore, it is plausible to hypothesize that interruptions lead to arousal that facilitates performance on simple tasks and inhibits performance on complex tasks. This prediction is supported by the findings in the previous literature on interruptions. Thus, the drive theory of social facilitation provides an alternative explanation to the effects of interruptions and is a competing theory to the fit model.

The main difference between the drive theory and the fit model is that the drive theory views complexity of the planned task as the only moderator, while the fit model also takes the actor's capacity into consideration. Because of this difference, the two theories may not produce the same predictions in all conditions. For example, suppose that the planned tasks are simple, but the actor somehow has a capacity deficit. Say, he/she has not slept well the previous night and is not able to think straight. In such a case, the drive theory would not consider the effect of capacity and would maintain its prediction that interruptions enhance performance when the tasks are simple. In contrast, the fit model would suggest the opposite, that interruptions increase the capacity deficit and lead to a decrease in performance in spite of the simplicity of the tasks. In this study, the two theories would make the same predictions on the main effects of interruptions (i.e., Hypothesis 1) and distinct predictions on the moderating effects of the environmental factors and the individual factors (i.e., factors in Hypothesis 2 to Hypothesis 5).

First, the fit model is consistent with the drive theory in only two situations, that the actor performs complex tasks with a capacity deficit, and that the actor works on simple tasks with a capacity surplus. The data in this study falls into the first situation, and the results of the test of Hypothesis 1 (i.e., the main effects of interruptions) supported both theories. Next, the fit model uniquely proposes Hypothesis 2 to Hypothesis 5 (i.e., the moderating effects of the environmental factors and the individual factors), and the tests of these hypotheses may differentiate the explanatory power of the two theories. Because Hypothesis 2 to Hypothesis 5 concern the actor's capacity, and the drive model does not count for the change of capacity, any evidence supporting these hypotheses can only be explained by the fit model. On the other hand, if none of the hypothesized moderating effects was significant, the drive theory would hold true: interruptions impede performance on complex tasks no matter what the condition of capacity is.

In the test of Hypothesis 5, individual effort partially alleviated the negative effects of interruptions. This could be evidence for the fit model's claim that capacity influences the effects of interruptions to some extent. However, the results showed that environmental challenge and individual experience did not affect the main effects of interruptions, which was consistent with the predictions of the drive theory. It might be the case that both theories were at work, and the effect of capacity change may be neutralized by that of arousal.

Despite its merits, the drive theory may also have constraints in explaining the effects of interruptions. For example, most of the participants in this study worked in a demanding environment and were likely to be constantly aroused. In such a situation, there may have been a ceiling effect, so that interruptions did not induce further arousal. If this was true, the drive theory would lose its power in predicting the change of performance due to interruptions.

### 7.2 CONTRIBUTIONS AND LIMITATIONS

The present study makes several contributions to the literature. First, as an overarching explanation of the effects of interruptions, the fit model is intuitively convincing. The model is based on the argument that superior performance is the result of a high degree of fit between an actor's capacity and his/her task demands. A low degree of fit indicates either capacity deficit or capacity surplus, both of which impede performance. By viewing interruptions as a source of task demands, the fit model neatly demonstrates the mechanism through which interruptions alter the degree of fit and thus influence performance. The introduction of the concept of fit explains the inconsistency in the effects of interruptions found in the literature and provides directions in which new contingency factors can be explored.

Second, although the current study focuses on individual level effects, the explanation power of the fit model can be extended to the group level. Just as individual performance, group performance is also a matter of degree of fit between task demands and an actor's capacity. Because of the synergy effect, group capacity tends to have a larger variance than the individual effects. Groups with positive synergy establish superior capacity, whereas those with negative synergy have inferior capacity. Thus, it is likely that some groups experience more severe capacity deficit, and others more capacity surplus, than the degree of fit of the aggregated individual actors that compose them. This is followed by the predictions that the groups who benefit from interruptions are those with much capacity surplus. Thus, factors that determine group capacity are likely to moderate the relation between interruptions and group performance.

Empirically, the dataset collected among public school principals is of unique value in understanding interruptions. Many previous studies were conducted using experiments, and the literature is limited in observations of interruptions in the real world. The few case studies on the work of knowledge workers and managers open a window through which we can see in detail how these people suffer from and cope with their fragmented working arrangements. This study is complimentary to the previous research in that it uses the PDA time diary method so that a large number of detailed observations become possible. Furthermore, this study is the first that introduces environmental factors to the interruptions phenomenon. It is interesting to find that the effects of interruptions were not free of context. Rather, the work environment determined how severe the interruption effects were. The richness of the dataset allowed the investigation of environmental factors and brought new insight to the research. In addition, this study makes initial attempts to refine the dimensions of the demands of interruptions. The traditional measures of frequency and duration may not be enough to identify the demands. The content and temporal patterns were helpful in describing interruptions in more comprehensive ways. In particular, clusteredness was found to have an opposite effect to that of the other dimensions.

Finally, the public school principals in this study were representative of a population who often experience capacity deficit. Therefore, findings based on their daily activities can be generalized to people in other jobs such as knowledge workers and middle level managers.

Despite the contributions noted above, this paper also has several limitations. First, the fit model needs to be refined to precisely predict the effects of interruptions. For example, the fit model is not able to predict the interruption effects in a situation when the actor experiences a low degree of capacity surplus. In such a case, the actor's performance will experience a reversed U-shape change as interruptions occur and task demands increase. That is, the actor will perform better when the interruption demands are minimal and capacity surplus is absent. This trend of performance increase will stop once the demands of the overall tasks reach the level where the capacity surplus is used up. Performance will decrease if the demands of interruptions continue to increase and introduce a capacity deficit. Given such a path, when the degree of fit cannot be accurately measured, the fit model has a limited ability to predict whether, and when, the occurrence of interruptions will result in an increase or decrease in performance.

Second, the fit model ignores the fact that sometimes an actor's capacity can be extended above his/her previous limit through being challenged with demands. Zakay (1993) reviewed the literature and pointed out that in some cases, people under time pressure can perform beyond their best levels in common situations. Whereas the fit model does not contradict such findings, it does not investigate how people would perform when they are in a state of sustained high degree of fit due to a simultaneous increase in both demands and capacity.

Empirically, the study design could also be improved to capture more details of interruptions. For example, performance measure could be changed to Likert-scale ratings on how well the activity was processed. An additional category could be inserted in the PDA program, asking the principals to report to what extent the events are accomplished when the next event occurs. This would be useful in identifying the intrusiveness of the unplanned events. Also, it would be helpful to have another category indicating the complexity of each activity. This assessment of complexity can be complementary to the current one, which is based on the subjects of the events.

### 7.3 DIRECTIONS FOR FUTURE RESEARCH

The literature on interruptions is still developing, with many areas unexplored. This study provides numerous implications to both research and practice. First, it is worthwhile to examine the effects of interruptions at the group level. The literature review chapter of this dissertation suggests that more benefits of interruptions can be observed in groups than in individuals. The fit model suggests that the positive results in groups are likely to be attributed to the superior capacity of the groups. This capacity surplus can result from the mere accumulation of individual members' capacities exceeding the group tasks and/or, more interestingly, the effective coordination that some groups manage to establish. Specifically, mechanisms such as transactive memory and social capital are likely to determine group capacity and influence the effects of interruptions on group performance.

Groups with strong social capital can use interruptions as opportunities to increase flexibility in their structures and activate interpersonal relationships. They may also take advantage of interruptions to bring new perspectives to the planned tasks. This scenario is unlikely to appear in groups with weak social capital because the uncertainty brought by interruptions requires accurate and efficient communication as well as a high level of trust, which is missing in those groups. Similarly, groups with rich transactive memory can practice their coordination during the interruptions and update their information on the knowledge directory during the practice, while maintaining high standard performance. But groups with limited transactive memory tend to suffer from interruptions because the unexpected events challenge the already weak coordination among members. Thus, groups with a high level of transactive memory and social capital should be more likely to enjoy capacity surplus and react positively to surges in task demands such as interruptions. In contrast, a lack of transactive memory and social capital may lead to group failures that can be more devastating than the effects at the individual level. Studies in this direction will fill the gap between group and individual research. They will also provide evidence to validate the fit model at the group level.

Second, interruptions may have potential influences on group phenomena such as habitual routines (Gersick, 1990) and groupthink (Janis, 1973). Groups form habitual routines so things can be done with limited resources. On the one hand routines save group capacity, on the other they can lead to rigidity. If the conditions of the routines are always satisfied, groups tend to develop a habit in using these routines, without checking if the prerequisites are met. To help the groups make sense of the routines, alterations in their preconditions are necessary to develop effective reactions. Group members should be aware of the possibility of change so they will think of the appropriateness of the routines when they are about to use them. Similar to habitual routines, groupthink is characterized by a tendency of confirmation to a group decision without deep analysis of potential consequences. There is a need to break with the trend of conformity to others so that different opinions will receive serious consideration. Will interruptions serve as opportunities to reevaluate the situation where habitual routines or groupthink occur? Okhuysen (2002) suggested that groups could use interruptions to integrate knowledge and make group structures flexible. Future studies can explicitly investigate the changes that interruptions induce on habitual routines and groupthink.

Third, it would be interesting to investigate the effect of learning in coping with interruptions. The literature has been silent on this topic. It is unclear whether an actor is able to learn from the experience of interruptions. If this learning effect can be identified, we should expect that the effects of interruptions attenuate as interruptions repeatedly occur. Moreover, there is a possibility that learning happens only in certain situations. For example, for those who suffer from capacity deficit, learning can become very difficult when demands increase. On the other hand, those with capacity surplus should be able to accrue their knowledge on interruptions with increasing speed. Zijlstra (1999) found that secretaries doing proofreading work were affected only by the first interruptions. Additional interruptions did not have a significant influence on performance. In the current study, however, the frequency of interruptions was one of the strongest predictors and consistently had a negative effect on performance. Will the actors ever learn to better cope with interruptions? How will they learn from their experience of interruptions? Further studies are called for to investigate these questions.

Another topic worth exploration is the creativity in an interruptive work environment. Because interruptions are unpredictable and the actor has to gather resources quickly without preparation, improvisations are often necessary because the common ways of processing the interruption tasks may not be accessible when they are intertwined with the planned tasks under pressure. How does the actor improvise the strategies? What is the relation between the improvised strategies and the regular ones? What distinguishes creativity through interruptions from that in other circumstances (e.g., creativity derived from flow)? Taking this one step further, is it plausible that the state of flow enhances innovations that contribute to the depth and tacitness of knowledge, whereas the high degree of fit promoted by interruptions enhances knowledge breadth both explicitly and tacitly? Answers to these research questions will bring significant insight to our understanding to the phenomenon of interruptions.

## 7.4 CONCLUSION

Interruptions are significant phenomena in organizational life. However, research on interruptions is limited, and the findings are inconsistent. This paper was intended to improve the theoretical basis of the research stream by identifying the contingencies that bound the positive and negative effects of interruptions. Specifically, it is argued that the degree of fit between demand and capacity determines whether the effects of interruptions are positive or negative. For individual actors who tend to experience capacity deficit in their daily work, it is proposed that the demands of interruptions, challenges and turbulence in the work environment, and individual experience and effort influence the relation between interruptions and performance.

The current study partially supports the hypotheses based on the fit model. Whereas frequency, duration, and complexity of interruptions negatively affected performance and clusteredness was positively related to performance, individual factors moderated part of the main effects. The results suggested that the negative impacts of interruptions were robust in the situation of capacity deficit. However, the moderating effects might be more complex than expected, and the fit model needed improvement to explain the results. Meanwhile, future research with a more refined study design may also help to clarify the relationships.

In sum, this paper initiates a comparison between interruption effects at the individual and the group levels and reveals differences across levels. It proposes the degree of fit between demand and capacity as the key factor that determines the directions of effects of interruptions. It also finds weak support for the fit model based on the time diary data collected from public school principals.  More investigation is called for to bring insights to the effects of interruptions and help organizations to make better use of these incidents.

# APPENDIX A

## Summaries of Important Empirical Studies

| **Citations** | **Arguments/hypotheses** | **Research method; operationalization of interruptions and other independent variables** | **Operationalization of performance or other dependent variables** |
|---|---|---|---|
| Amabile, hardley, & Kramer (2002) | In contrast to people's perception, time pressure decreases creativity. | >9000 online diary entries collected from 177 employees in 7 U.S. companies. The entries include participants' ratings on aspects of their work and work environment of that day.<br><br>Interruption not measured<br><br>Participants' self record of daily work in descriptive form | Creativity: coded from the diary entries |

| Citations | Arguments/hypotheses | Research method; operationalization of interruptions and other independent variables | Operationalization of performance or other dependent variables |
|---|---|---|---|
| Edwards & Gronlund (1998) | Generally, people remember unfinished actions better than completed actions when interruptions are similar to the primary tasks.<br>Fixed order in information presentation resists the interruption-similarity effect and enables people to remember both the unfinished and completed actions equally well. | Experiment:<br>Exp 1: 128 students retrieve locations from a map.<br><br>Interruption similarity: Similar interruption (used the same locations as the primary task as well as items related to the critical items) vs. dissimilar interruptions (calculation tasks)<br><br>Order of information: fixed (participant retrieved the 10 items in the same order on each list) vs. permuted (participant retrieved the same items in a different random order)<br><br>Designs of Exp 2 & 3 are similar to that of Exp 1, only vary the degree of overlap between the primary and interruption tasks. | Performance: time, accuracy<br><br>Memory test: whether the participant remembered the information central to the interruption recovery |
| Einstein, McDaniel, Williford, Pagan, & Dismukes (2003) | Demanding conditions as well as interruptions revealed rapid forgetting of intentions at levels that would be considered significant in applied settings. This rapid forgetting was not reduced by strategic rehearsal and implementation intention strategies. | Experiment: 2 x 4 mixed factorial design., length and types of delay: 5 sec, 15 sec, 40 sec, and 40 sec with interruptions<br><br>Attentional demand: standard (no interruption tasks during delay) vs. divided (interruption tasks during delay)<br><br>Primary tasks: press the slash key when red screen occurs<br><br>Cover tasks: multiple-choice questions | Memory on intention: Whether participants remember what to do when a red screen occurred; whether participants tried to rehearse the intention to press the slash key or simply let it "pop into mind" |

| Citations | Arguments/hypotheses | Research method; operationalization of interruptions and other independent variables | Operationalization of performance or other dependent variables |
|---|---|---|---|
| Fisher (1998) | External interruptions reduced boredom on a simple task that required little attention, but contrary to expectations, had no impact on reactions to a simple task that did require attention or on reactions to a complex task. | Experiment: 3 x 3 between subject design.<br><br>Interruption: no interruption vs. 4 interruptions during 20 min (irrelevant interruption: a maintenance worker entering the room and speaking with the experimenter; concern-relevant interruption: a graduate student entering the room to do research on student life)<br><br>Primary task: simple low-attention task (repetitive manual assembly task); high-attention task (proof-reading names and addresses); and complex task (in-basket for the job of advertising manager) | Boredom |
| Flynn, Barker, Gibson, Pearson, Berger, & Smith (1999) | RQ: Are dispensing errors influenced by interruptions or distractions? | Participative observation and videotape coding:<br>5072 prescriptions filled by 14 pharmacists and 10 technicians in 23 days<br><br>Interruption (sequential processing) and distraction (simultaneous processing) workload: The frequency of interruptions or distractions per prescription set, per half hour, and per shift<br><br>Control variables: hearing ability, distractibility | Performance:<br>Dispensing error rate |

| Citations | Arguments/hypotheses | Research method; operationalization of interruptions and other independent variables | Operationalization of performance or other dependent variables |
|---|---|---|---|
| Kirmeyer (1988) | H1 (S): employees exposed to higher rates of interruption appraise their work as more overloading and take more actions to cope with overload than those exposed to lower rates of interruptions. H2 (S): Under high rates of interruption, Type As would be more likely than their more easygoing Type B counterparts to appraise their work as overloading and to take actions to cope with overload. Under low rates of interruption, no differences were expected in either appraisal or coping. | Participative observation and survey;<br><br>Setting: 72 nonsupervisory police officers and civilians working as radio dispatchers at 12 police stations.<br><br>Interruption: preemption — when a focal participant responded to an incoming demand by immediately stopping his or her work, leaving it unfinished, and attending fully to the new demand; simultaneity — when a participant began attending to a new demand before he or she had finished a previous work activity.<br><br>Process measures: volume of objective load; proportion of time.<br><br>JAS scales: Type A; speed and impatience, hard-driving competitiveness; job involvement. | Role overload<br><br>Coping: Asked those who called in for assistance to hold while they finished dealing with other complaints; delayed or left undone some of their normal job responsibilities; spent less time than usual handling each request or complaint from the public; shortened conversations with other employees; provided more or less individualized attention than usual to police officers who radioed in with requests for information or assistance.<br><br>Both role overload and coping are measured by participant reports and observer rating. |
| McFarlane (2002) | (S) Four separate solutions for coordinating the interruption of people in HCI — immediate, negotiated, mediated, and scheduled — will differentially affect users' performance on interruption-laden computer-based multitasks. | Experiment: 1 x 6 within subject design; 36 participants worked on computer tasks (a game task and a matching task)<br><br>Interruption pattern: manipulated by programmed pop-up matching task that masks the game task | Performance: 9 objective measures (including correctness, efficiency, completeness, and timeliness) and 19 subjective measures |
| Meyer (1982) | Ideological and strategic variables are better predictors of adaptations to jolts than are structural variables or measures of organizational slack. Although abrupt changes in environments are commonly thought to jeopardize organizations, environmental jolts are found to be ambiguous events that offer propitious opportunities for organizational learning, administrative drama, and introducing unrelated changes. | Survey of 19 hospitals and multiple case-studies on how three hospitals responded to a doctors' strike (environmental jolt)<br><br>Strategy, structure, ideology, and slack | Performance: forewarning; occupancy lost; layoffs; revenue lost; resiliency; learning |

| Citations | Arguments/hypotheses | Research method; operationalization of interruptions and other independent variables | Operationalization of performance or other dependent variables |
|---|---|---|---|
| Okhuysen (2001) | H1 (S): Groups using formal interventions have more clusters initiated by attention switches to the formal intervention than groups without a formal intervention. H2 (S): Familiar groups have more clusters initiated by attention switches to social interaction than stranger groups. H3a (NS): The use of a formal intervention by a familiar group will increase the number of clusters in the group. H3b (S): The use of a formal intervention by a familiar group will decrease the number of clusters in the group. H4 (S): Groups using a formal intervention will have higher performance than groups without a formal intervention, and familiar groups will have higher performance than stranger groups. H5 (S): Familiar groups using a formal intervention will have higher performance if the number of clusters increases. They will have lower performance if the number of clusters decreases. | Experiment: 2 x 2 design<br>40 4-person groups work on a task of diagnosis of the causes of a salmonellosis outbreak in a restaurant.<br><br>Familiarity: Familiar groups completed two assignments as a group before arriving at the experimental session. Members of stranger groups were reassigned to new groups for experiment.<br><br>Formal intervention: Formal intervention condition was watching video on how to use cause-and-effect analysis. No-formal-intervention condition was watching a video on an unrelated quality management topic.<br><br>Attention switches: switches to social interaction, to formal intervention, to time management, and to other attention switches clusters | Number of clues for the food-poisoning incident that were identified |

| Citations | Arguments/hypotheses | Research method; operationalization of interruptions and other independent variables | Operationalization of performance or other dependent variables |
|---|---|---|---|
| Okhuysen & Eisenhardt (2002) | H1 (S): Formal interventions increase the number of switches to the knowledge integration behavior targeted by the formal intervention. H2 (NS): Formal interventions increase the number of attention switches to other knowledge integration behaviors that are not the target of the formal intervention. H3 (PS): Formal interventions increase the organization of attention switches to knowledge integration behaviors into clusters. H4 (S): Clusters of attention switches that include more attention switches will (a) consider more aspects of the knowledge integration process, (b) have a greater number of group members participating, (c) have a greater number of specific suggestions for improving the knowledge integrating process being proposed, (d) have greater change in the knowledge integration process after the cluster, or (e) have greater gains in knowledge integration after the cluster. H5 (S): Groups using a formal intervention will have greater knowledge integration than groups not using a formal intervention. | Experiment: 1 x 4 design<br>40 4-member groups performed a task of identifying key facts that were related to a salmonellosis outbreak in a fast-food restaurant.<br><br>Formal intervention conditions: Sharing information condition; questioning others condition; managing time condition<br><br>Control group.Videotape group activities | Attention switches: the group departed from a discussion of the case to some other topic such as managing time.<br><br>Attention switch clusters: switches occur within 90 seconds of each other.<br><br>Number of switches included: number of types of attention switches; number of different group members speaking; number of specific suggestions for improving the knowledge integration process.<br><br>Knowledge integration: coding the group behavior of identifying the critical facts distributed among members |

| Citations | Arguments/hypotheses | Research method; operationalization of interruptions and other independent variables | Operationalization of performance or other dependent variables |
|---|---|---|---|
| Oldham, Kulik, & Stpina (1991) | H1 (S for satisfaction, PS for performance): Employees with weak screening skills in unshielded environments will have lower performance and satisfaction than employees for whom other combinations of screening ability and environmental characteristics prevail. H2 (S for satisfaction, PS for performance): Employees working on simple jobs in unshielded environments will have lower performance and satisfaction than employees for whom other combinations of job complexity and environmental characteristics prevail. H3 (S): Employees with weak screening skills working on simple jobs in unshielded environments will have lower levels of performance and satisfaction than employees for whom other combinations of screening ability, job complexity, and environmental characteristics prevail. | Survey, archival, etc.:<br>298 full-time employees working on jobs such as data entry operator, financial analyst, and accountant in a southern state's government.<br><br>Interruption: not directly measured.<br><br>Interpersonal distance:<br>Number of enclosures (walls and partitions);<br>Spatial density:<br>Stimulus screening: (ex., "When I walk into a crowded room, it immediately has a big effect on me");<br>Job complexity | Performance: Employee's overall performance from organization record; job satisfaction |
| Perlow (1999) | Engineers had difficulty getting their individual work done because they were constantly interrupted by others.<br>A crisis mentality and a reward system based on individual heroics perpetuated this disruptive way of interacting.<br>Altering the way software engineers used their time at work enhanced their collective productivity. | Qualitative study:<br>Nine-month field study on a software engineering team.<br>Interview; time diaries; shadowing | Ability to meet deadlines; psychological factors such as anxiety and satisfaction; supervisor evaluation. |
| Speier, Valacich, & Vessey (1999) | P1 (S-supported): Interruptions facilitate decision-making performance on simple tasks. P2 (S): Interruptions degrade decision-making performance on complex tasks. P3 (S): Decision-making performance on complex tasks degrades when the frequency of interruptions increases. P4 (PS-partially supported): Decision-making performance on complex tasks degrades when the information content of the interruption and decision-making task is dissimilar. | Experiments:<br>Exp. 1: Two (simple vs. complex tasks) 2 (interruption vs. non-interruption) x 1; Exp. 2: Interruption frequency 2 (4 vs. 12 interruptions) x 1; Interruption content 2 (identical vs. different data used in interruptions and primary tasks) x 1;<br>Interruptions: four (or 12) simple information acquisition tasks (both spatial and symbolic) occurred 7–15seconds into the tasks.<br>Measured controls: Domain expertise, spatial ability; gGender | Performance: Decision accuracy; decision time |

| Citations | Arguments/hypotheses | Research method; operationalization of interruptions and other independent variables | Operationalization of performance or other dependent variables |
|---|---|---|---|
| Speier, Vessey, & Valacich (2003) | H1a (NS): For simple-symbolic tasks, decision accuracy will be higher when the task is interrupted compared to when the task is not interrupted.<br>H1b (S): For simple-symbolic tasks, decision time will be faster when the task is interrupted compared to when the task is not interrupted.<br>H2a (S): For simple-spatial tasks, decision accuracy will be higher when the task is interrupted compared to when the task is not interrupted.<br>H2b (S): For simple-spatial tasks, decision time will be faster when the task is interrupted compared to when the task is not interrupted.<br>H3a (S): For complex-symbolic tasks, decision accuracy will be lower when the task is interrupted compared to when the task is not interrupted.<br>H3b (NS): For complex-symbolic tasks, decision time will be slower when the task is interrupted compared to when the task is not interrupted.<br>H4a (S): For complex-spatial tasks, decision accuracy will be lower when the task is interrupted compared to when the task is not interrupted.<br>H4b (S): For complex-spatial tasks, decision time will be slower when the task is interrupted compared to when the task is not interrupted.<br>H5a (S): For simple-symbolic tasks, symbolic information presentation formats result in higher decision accuracy than spatial formats whether or not interruptions occur.<br>H5b (S): For simple-symbolic tasks, symbolic information presentation formats result in shorter decision times than spatial formats whether or not interruptions occur.<br>H6a (S): For simple-spatial tasks, spatial information presentation formats result in higher decision accuracy than symbolic formats whether or not interruptions occur.<br>H6b (S): For simple-spatial tasks, spatial information presentation formats result in shorter decision times than symbolic formats whether or not interruptions occur. | Experiment: 2 x 2 x 2 x 2 design with two between-subjects factors and two within-subjects factors. 136 undergraduate students<br><br>Work environment: interruption vs. no interruption.<br><br>Information presentation format: tables vs. graphs.<br><br>Task type: symbolic vs. spatial<br><br>Task complexity: simple (simple-symbolic: obtain specific data by directly extracting values or performing routine addition or subtraction calculations; simple-spatial: identify trends in the data) vs. complex (complex-symbolic: facility location; complex-spatial: aggregate planning) | Performance: Decision accuracy; decision time |

| | Arguments/hypotheses | Research method; operationalization of interruptions and other independent variables | Operationalization of performance or other dependent variables |
|---|---|---|---|
| Speier et al. (2003) cont. | H7a (S): For complex-symbolic tasks, spatial information presentation formats result in lower decision accuracy than symbolic formats without interruptions and comparable or higher decision accuracy when interruptions occur.<br>H7b (NS): For complex-symbolic tasks, spatial information presentation formats result in longer decision times than symbolic formats without interruptions and comparable or faster decision times when interruptions occur.<br>H8a (S): On complex-spatial tasks, spatial information presentation formats result in higher decision accuracy than symbolic formats whether or not interruptions occur.<br>H8b (S): On complex-spatial tasks, spatial information presentation formats result in longer decision time than symbolic formats whether or not interruptions occur. | | |
| Staudenmayer, Tyre, & Perlow (2002) | Temporal shifts enable change in four ways: (1) by creating a trigger for change, (2) by providing resources needed for change, (3) by acting as a coordinating mechanism, and (4) by acting as symbol of the need to change. | Multiple case-studies in 3 technology intensive organizations.<br><br>Temporal shifts: inserting "buffer" periods into development cycle, exogenous or random events, and change in workplace timing regulation | Non-intended-purpose: Organizational change (e.g., new product design, adaptation in routines, new interaction patterns among team members); cognitive change; perception of success |
| Thomas & Ayres (1998) | Principals regard interruptions as beneficial and worth the time. | 4-5 days' time diaries from 3 principals in Australia | Not clear, maybe descriptive data |

| Citations | Arguments/hypotheses | Research method; operationalization of interruptions and other independent variables | Operationalization of performance or other dependent variables |
|---|---|---|---|
| Waller (1999) | H1 (S): When faced with nonroutine events, groups that engage in more information collection and transfer behavior will exhibit higher levels of performance than groups that engage in less information collection and transfer behavior. H2 (NS): When faced with nonroutine events, groups that engage in more task prioritization behavior will exhibit higher levels of performance than groups that engage in less task prioritization behavior. H3 (S): When faced with nonroutine events, groups that engage in more task distribution behavior will exhibit higher levels of performance than will groups that engage in less task distribution behavior. H4 (S): After groups recognize nonroutine events, those that engage in task prioritization behavior sooner than do other groups will exhibit higher levels of performance than the groups that do not engage in task prioritization behavior as quickly. H5 (S): After groups recognize nonroutine events, those that engage in task distribution behavior sooner than do other groups will exhibit higher levels of performance than the groups that do not engage in task distribution behavior as quickly. | Simulation test: 10 flight crews perform on a simulated flight.<br><br>Behaviors: Information collection and transfer; task prioritization; task distribution | Crew performance: frequency of errors committed by the crew |

| Citations | Arguments/hypotheses | Research method; operationalization of interruptions and other independent variables | Operationalization of performance or other dependent variables |
|---|---|---|---|
| Xia & Sudharshan (2002) | H1 (S): Interruptions will lead to more time being spent on the task.<br>H2 (NS): A moderate level of interruption frequency will increase the time spent on the task compared with a low or high level of interruption frequency.<br>H3 (S): As interruption frequency increases, consumers with concrete goals will spend less time on the task, whereas those with abstract goals will not be affected.<br>H4 (S): Interruptions will reduce consumers' decision process satisfaction but will not affect satisfaction with their choices.<br>H5 (S): Interruptions will lead consumers with more knowledge about the products to spend more time on the task than those with less knowledge.<br>H6 (S): When presented with interruptions, consumers with more experience (with the Internet) will spend less time on the task than those with less experience.<br>H7 (S): Consumers with control over interruptions will perceive the interruptions more positively than those without control.<br>H8 (S): When given control, consumers will be less likely to process the interruption messages as the interruption frequency increases.<br>H9 (S): When given control, consumers with abstract goals are more likely to process the interruptions than those with concrete goals.<br>H10 (NS): Participants will show a more positive attitude toward early interruptions than late interruptions.<br>H11 (Inconclusive): Late interruptions lead to more time being spent on the task compared with early ones.<br>H12 (Inconclusive): Participants with abstract goals will spend more time when encountering late interruptions than early interruptions, whereas those with concrete goals will not be influenced by the timing of interruptions. | Experiment:<br>Exp 1 (H1–H6): 89 undergraduate students work on online searching tasks.<br><br>Interruption frequency: high (every minute), moderate (every 2 min), vs. low (every 4 or 6.5 min)<br>Interruption content: brand-acquisition level interruption for concrete goal vs. product-acquisition level interruption for abstract goal<br>Interruption duration: 60 sec.<br><br>Task goals: looking for a modem (concrete goals) vs. communication device (abstract goals)<br><br>Exp 2 (H7–H9): 62 data points<br><br>Interruption frequency: 6.5 min level was dropped<br><br>Manipulation of control: Participants had the choice of closing the interruption window.<br><br>Exp 3 (H10–H12): 40 data points.<br><br>Timing: early (two 40 sec interruptions after starting the task) vs. late (two 40 sec interruptions after clicking the "Ready to Decide" button but before stating the choice); content of interruptions was relevant. | Performance: Time spent on task |

| Citations | Arguments/hypotheses | Research method; operationalization of interruptions and other independent variables | Operationalization of performance or other dependent variables |
|---|---|---|---|
| Xia et al. (2002) cont. | H13 (NS): Participants will spend more time on the interruptions when they are relevant compared to when the interruptions are irrelevant.<br>H14 (Inconclusive): Irrelevant (relevant) information will increase (decrease) time spent on the task when participants expect to be interrupted and will decrease (increase) time spent when participants do not expect to be interrupted. | Exp 4 (H13–H14): 33 data points.<br><br>Interruption relevance: relevant (product information) vs. irrelevant (e.g., store reconstruction information)<br><br>Expectation: with (warning participants beforehand that they might encounter extra information during their task) vs. without | |
| Zellmer-Bruhn (2003) | H1 (S): In a given time period, interruptive events positively influence knowledge transfer effort.<br>H2 (S): In a given time period, interruptive events positively influence knowledge acquisition in the form of new routines.<br>H3 (PS): In a given time period, knowledge transfer effort mediates the influence of interruptions on knowledge acquisition in the form of new routines. | Survey on 158 teams.<br><br>Interruptions: a list of 13 interruptions, e.g., Did the team lose any members? Did the team hold a formal planning session? Did the team have changes in machines, tools or other technologies? Did the organization experience a restructuring? | Performance: Knowledge transfer — how much effort the team spent in a specified month on a set of eight items; knowledge acquisition — whether or not the team acquired new practices in the specified month |
| Zijlstra, Roe, Leronora, & Krediet (1999) | H1 (NS): Interruptions have a detrimental effect on the performance of the main task in terms of time needed for execution and quality; the performance effects are larger for complex than for simple interruptions.<br>H2 (S): Workers develop strategies to counteract these effects; when the number of interruptions increases, participants are expected to exhibit a change in strategy.<br>H3 (PS): Interruptions are expected to affect the psychological state of the workers in terms of reduced well-being, negative rather than positive emotions, and greater anxiety; there are stronger effects for complex and more frequent interruptions.<br>H4 (S): The occurrence of interruptions is associated with higher levels of activation and effort; stronger effects for complex and more frequent interruptions are expected. | Experiments:<br>Similar experiments on two sites (Netherlands and Russia) were conducted with office workers who were interrupted during a text editing task.<br><br>Interruptions: Frequency — 1 or 3 interruptions by phone calls;<br>Interruptions: Complexity — simple, irrelevant to primary task, e.g., look up a telephone number; complex, similar to primary task, additional short editing task | Performance: Overall time parameters; types of actions in the flow of activity; interruption handling strategies; frequency of use of different interruption handling strategies; numbers of errors and omissions<br><br>Psychological state indicators: Measure the degree of positive and negative feelings of the participant at a particular moment; level of effort expenditure<br><br>Psycho-physiological state indicators: Acute fatigue; chronic fatigue |

# APPENDIX B

## Categories in the PDA Time Diary Program

**I. Subject**

1 Bringing extra resources into school
2 Classroom observation
3 Community relations
4 Facility mgmt.
5 Instruction and curriculum
6 Monitoring
7 Non-class activities
8 Parent relations
9 Personal development
10 School administration
11 Student assessment
12 Student discipline
13 Teacher professional development

**II. With whom**

1 Central office staff
2 Community groups or reps.
3 Corporations, foundations
4 Exec. Dir., deputy, or superint.
5 I did the activity alone
6 Other principal(s)
7 Parent(s)
8 Professional developers
9 School staff
10 Social serv. Agencies, police, etc.
11 Student(s)
12 Teacher(s)
13 Union reps.

**III. How**

1 Books, tapes, internet, etc.
2 Cell phone
3 Driving between school activities
4 E-mail
5 Face-to-face with a group
6 Face-to-face with an individual
7 Intercom
8 No Value
9 Paperwork
10 Phone
11 Walkie-talkie
12 Walking & looking

**IV. Where**

1 Car
2 Central office buildings
3 Classroom
4 Community sites
5 My home
6 My office
7 Other non-school facilities
8 Other offices in the school
9 Other schools
10 School facilities and grounds
11 Students' homes

**V. Good use of time**

1 Yes-Good Use of Principal's Time
2 Unsure
3 No-Not Good Use of Principal's Time
4 No Value

**VI. Planned**

1 Yes
2 No Value
3 No

## APPENDIX C

### Example of Time Diary Entries

| date | Start _time | End _time | subject | with_whom | how | where | good_time_use | planned | Principal _ID |
|---|---|---|---|---|---|---|---|---|---|
| 3/6/2001 | 8:15 AM | 9:05 AM | Monitoring (walking around, etc.) | I did the Activity Alone | Walking & Looking | School Facilities and Grounds | Yes-Good Use of a Principal's Time | Yes | 17 |
| 3/6/2001 | 9:05 AM | 9:55 AM | School Admin (budget, schedules, etc.) | School Staff | Face-to-face with a group | My Office | Yes-Good Use of a Principal's Time | Yes | 17 |
| 3/6/2001 | 10:00 AM | 10:20 AM | Instruction and Curriculum | School Staff | Paperwork (letters, fax, memos, etc.) | My Office | Yes-Good Use of a Principal's Time | Yes | 17 |
| 3/6/2001 | 10:30 AM | 11:15 AM | Facility Mgmt (bldg., equip., tech.) | School Staff | Face-to-face with an individual | School Facilities and Grounds | Unsure | Yes | 17 |
| 3/6/2001 | 11:15 AM | 11:57 AM | Student Assessment, Data & Perf. | Teacher(s) | Face-to-face with an individual | My Office | Yes-Good Use of a Principal's Time | Yes | 17 |
| 3/6/2001 | 11:57 AM | 12:30 PM | Student Assessment, Data & Perf. | I did the Activity Alone | Paperwork (letters, fax, memos, etc.) | My Office | Yes-Good Use of a Principal's Time | Yes | 17 |
| 3/6/2001 | 12:35 PM | 12:55 PM | Instruction and Curriculum | Social Serv. Agencies, Police, etc. | Phone | My Office | Yes-Good Use of a Principal's Time | Yes | 17 |
| 3/6/2001 | 12:55 PM | 1:20 PM | Student Discipline | Union Repre-sentatives | Face-to-face with an individual | Other Offices in the School | No-Not Good Use of a Principal's Time | No | 17 |
| 3/6/2001 | 1:20 PM | 1:45 PM | Monitoring (walking around, etc.) | I did the Activity Alone | Walking & Looking | School Facilities and Grounds | No-Not Good Use of a Principal's Time | Yes | 17 |
| 3/6/2001 | 1:45 PM | 2:50 PM | Teacher Professional Development | Other Principal(s) | Face-to-face with an individual | My Office | Yes-Good Use of a Principal's Time | Yes | 17 |
| 3/6/2001 | 2:50 PM | 3:20 PM | Monitoring (walking around, etc.) | I did the Activity Alone | Walking & Looking | School Facilities and Grounds | Yes-Good Use of a Principal's Time | Yes | 17 |
| 3/6/2001 | 3:20 PM | 3:30 PM | Parent Relations | I did the Activity Alone | Phone | My Office | No-Not Good Use of a Principal's Time | No | 17 |

## APPENDIX C: Example of Time Diary Entries (continued)

| date | Start _time | End _time | subject | with_whom | how | where | good_time_use | planned | Principal _ID |
|---|---|---|---|---|---|---|---|---|---|
| 3/6/2001 | 3:30 PM | 3:45 PM | Student Assessment, Data & Perf. | Parent(s) | Phone | Other Offices in the School | Unsure | No | 17 |
| 3/6/2001 | 3:45 PM | 4:00 PM | School Admin (budget, schedules, etc.) | School Staff | E-mail | My Office | Yes-Good Use of a Principal's Time | Yes | 17 |
| 3/6/2001 | 4:00 PM | 5:45 PM | School Admin (budget, schedules, etc.) | I did the Activity Alone | Paperwork (letters, fax, memos, etc.) | My Office | Yes-Good Use of a Principal's Time | Yes | 17 |
| 3/6/2001 | 5:45 PM | 6:00 PM | Bringing Extra Resources Into School | Social Serv. Agencies, Police, etc. | Phone | My Office | Yes-Good Use of a Principal's Time | Yes | 17 |
| 3/6/2001 | 7:00 PM | 9:00 PM | Instruction and Curriculum | Parent(s) | Face-to-face with a group | School Facilities and Grounds | Yes-Good Use of a Principal's Time | Yes | 17 |

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## FIGURES

**FIGURE 1: The Framework of Interruptions Based on Literature Review**

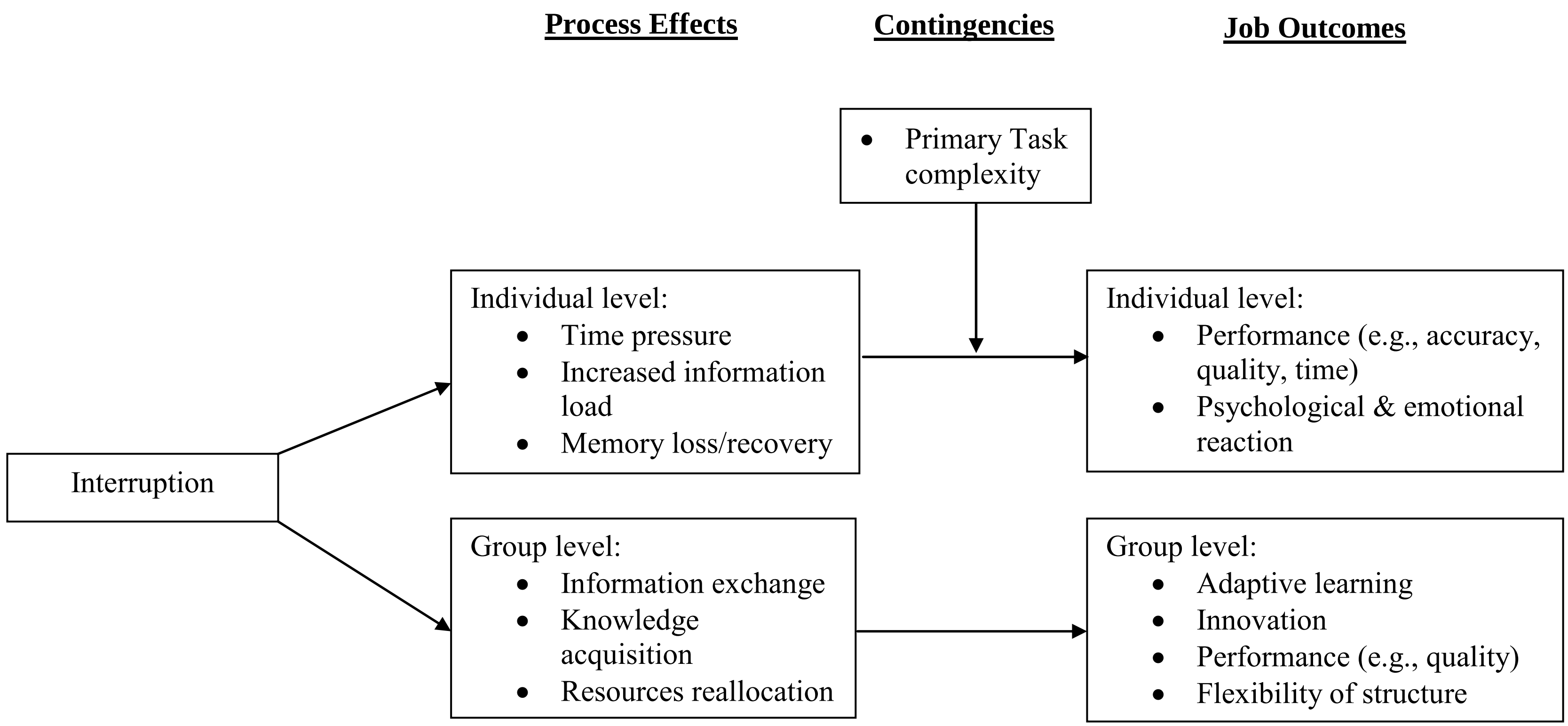
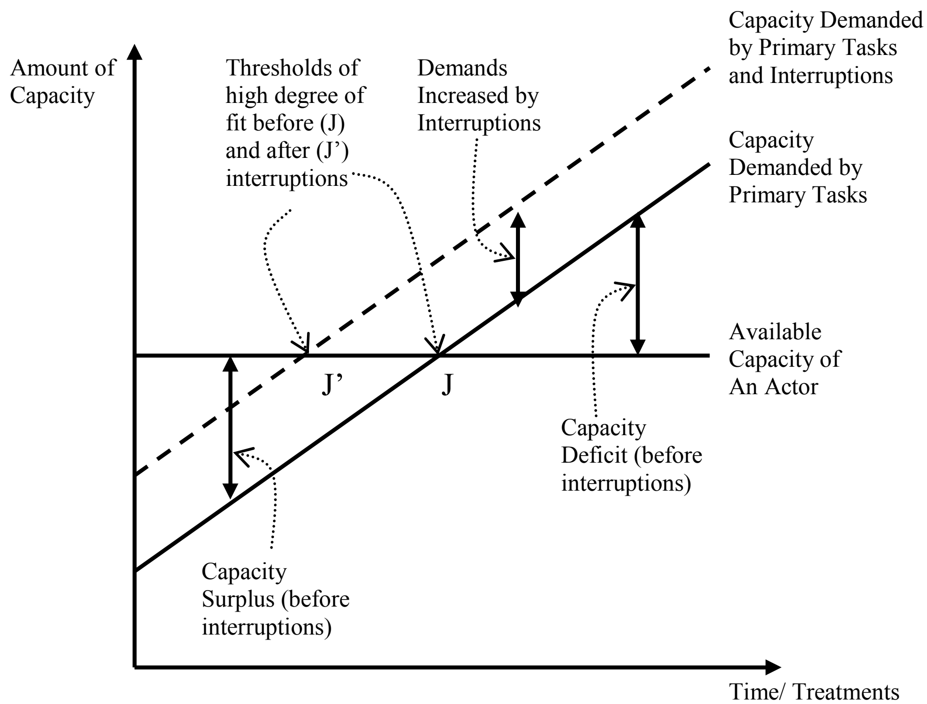


**FIGURE 2: The Impact of Interruptions on the Degree of Fit**




1. Holding the unit's capacity constant and increasing the demands of primary task along the time/ treatments axis, the degree of fit starts from capacity surplus, through the threshold point J, when capacity is "just-right" for the demands, and converts into capacity deficit.
2. Interruptions increase the total demands of workload and move the threshold point to the left to Point J'. The original threshold point J now fells in the capacity deficit zone.

**FIGURE 3: Factors that Influence the Degree of Fit at the Individual Level**

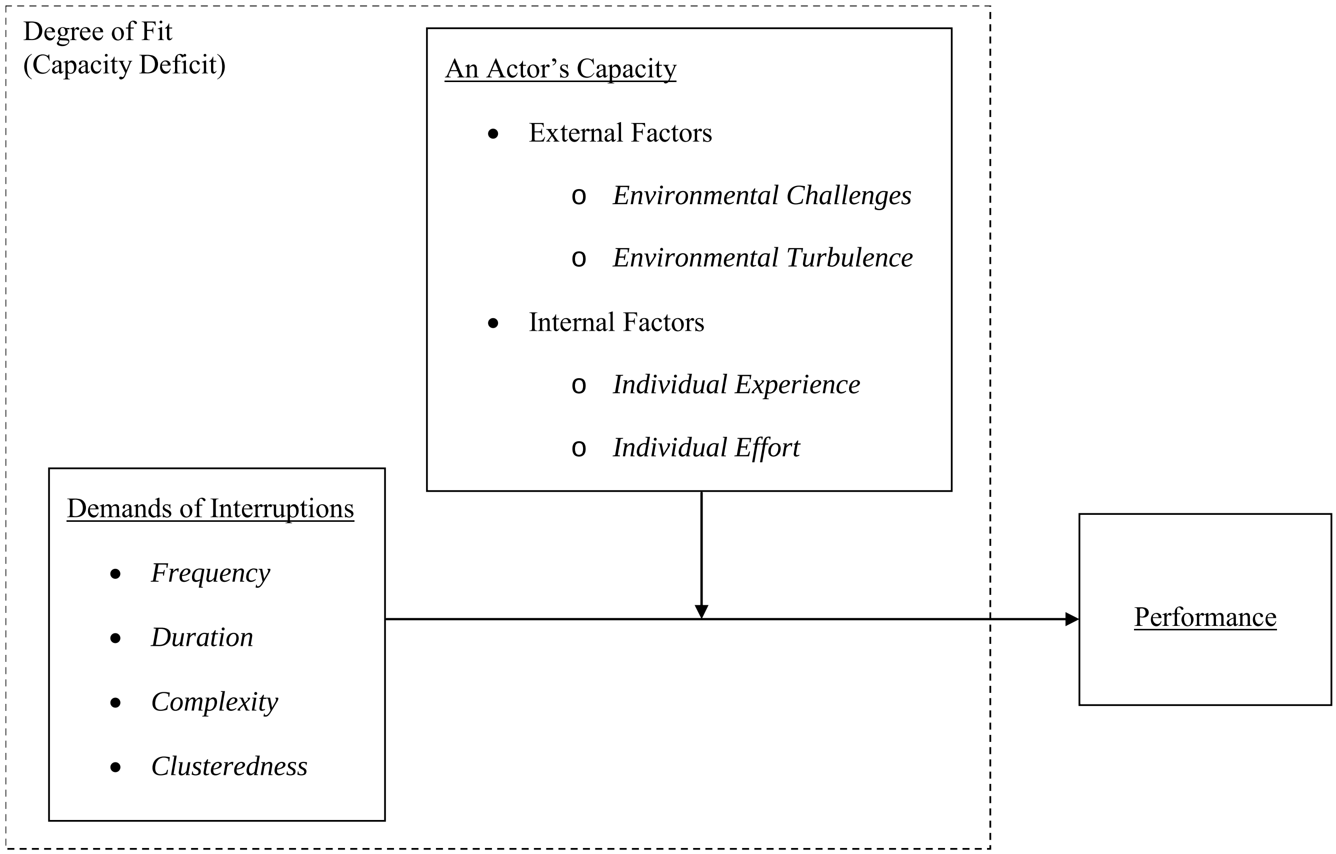


**FIGURE 4: Interaction Effect of Environmental Turbulence and Duration**

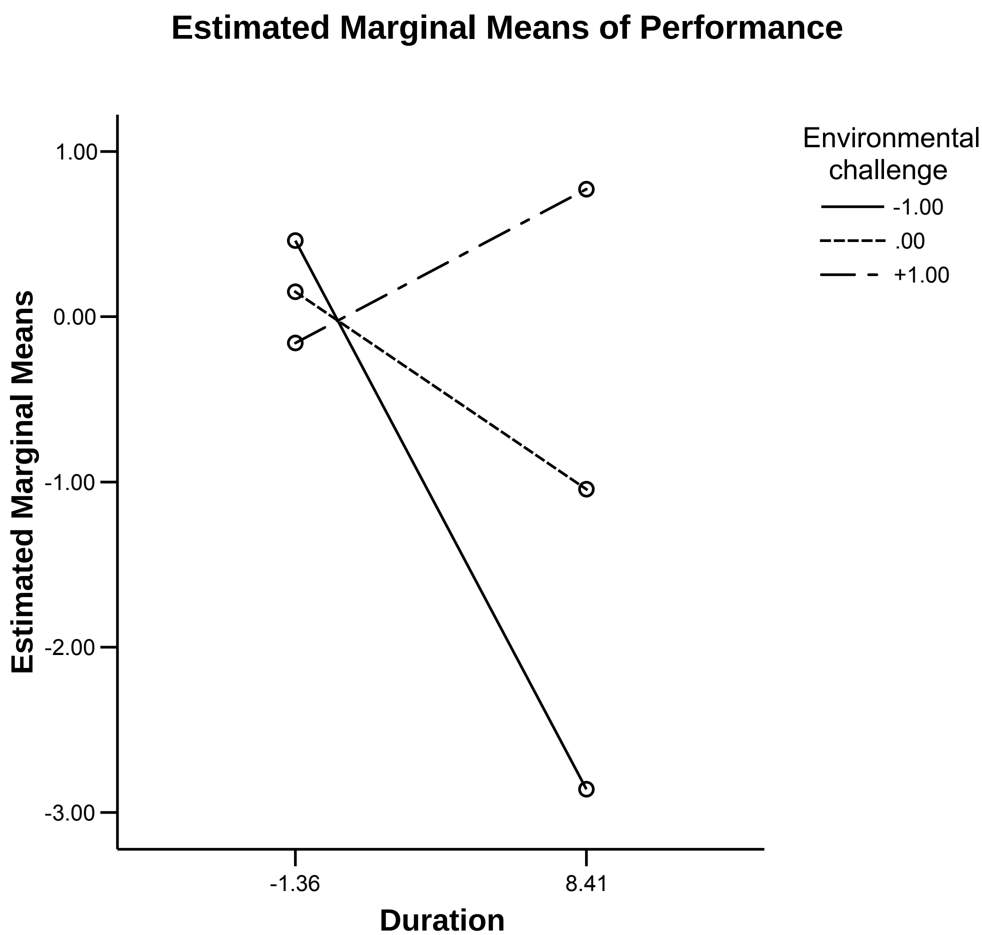


**FIGURE 5: Interaction Effects between Individual Effort and Complexity**

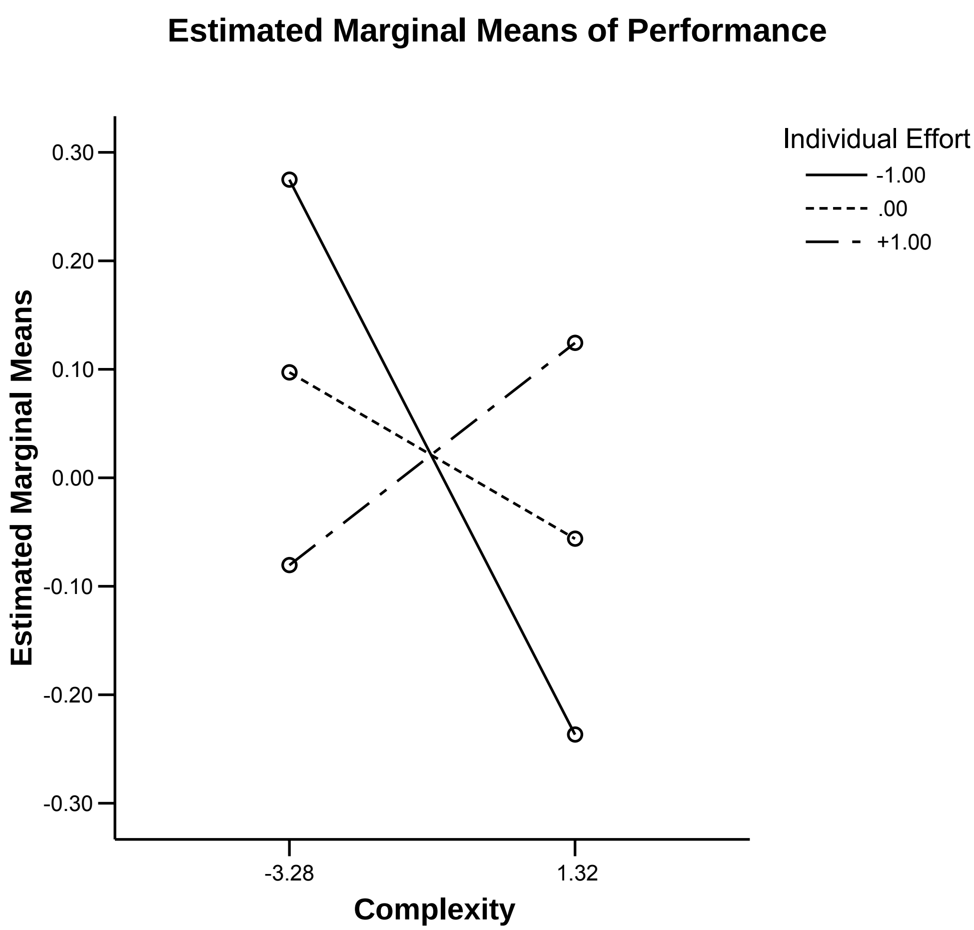
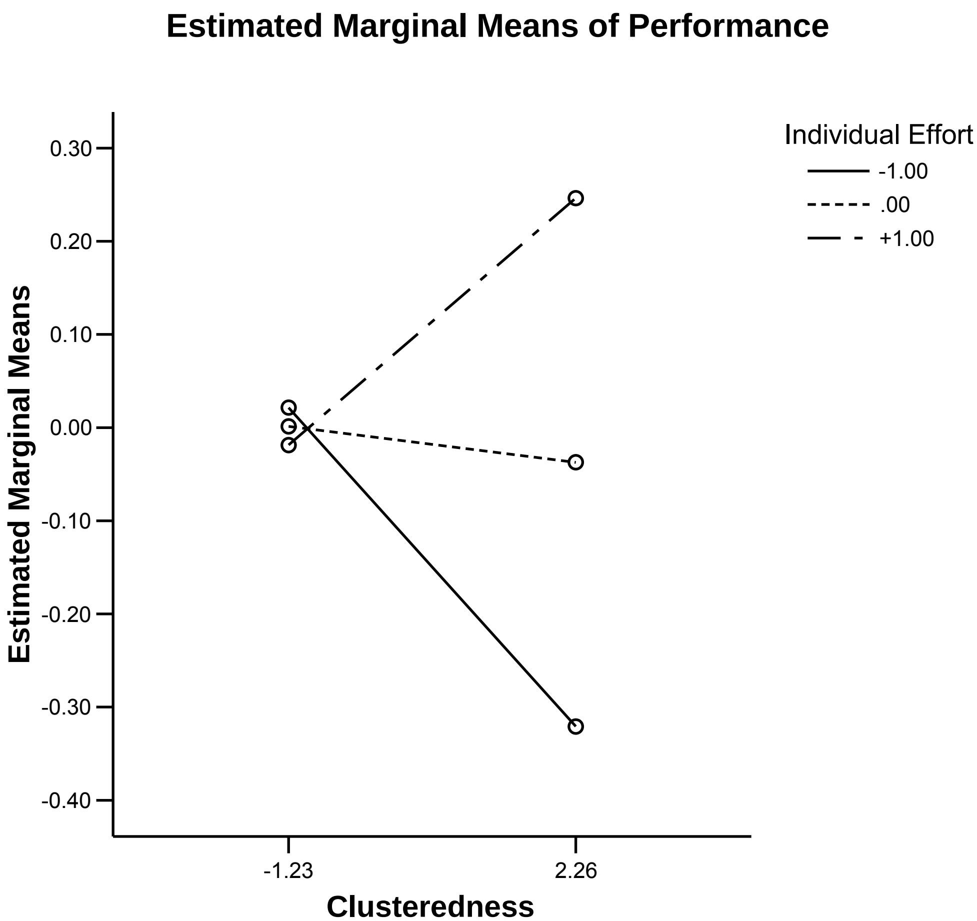


**FIGURE 6: Interaction Effect between Individual Effort and Clusteredness**



# TABLES

## TABLE 1: Description on the Complexity Rating of the Subjects of Activities

| Subject | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|
| Observing teachers in classrooms | 36 | 1 | 7 | 2.86 | 1.533 |
| Administrative work such as budgets and schedules | 36 | 1 | 5 | 3.14 | 1.222 |
| Monitoring activity (walking the halls, etc.) | 35 | 1 | 6 | 3.43 | 1.685 |
| Facility management (building, etc.) | 36 | 1 | 6 | 3.50 | 1.183 |
| Managing non-classroom activities (e.g., bus, lunch) | 36 | 1 | 6 | 3.75 | 1.442 |
| Managing teacher professional development | 36 | 2 | 7 | 4.14 | 1.533 |
| Managing relations with parents | 35 | 1 | 7 | 4.14 | 1.801 |
| Instruction and curriculum leadership | 36 | 1 | 7 | 4.19 | 1.582 |
| Getting extra resources for the school | 36 | 1 | 7 | 4.22 | 1.551 |
| Building relations with the community | 35 | 1 | 7 | 4.31 | 1.623 |
| Student discipline issues | 36 | 1 | 7 | 4.47 | 1.781 |
| Activities related to student assessment | 36 | 1 | 7 | 4.56 | 1.501 |
| A principal's personal self-development (training, self-reflection, etc.) | 36 | 2 | 7 | 5.06 | 1.413 |
| Valid N (listwise) | 33 | | | | |

## TABLE 2: Rotated Component Matrix

| | Component | |
|---|---|---|
| | 1 | 2 |
| Frequency - number of unplanned events (controlled for principals) | .051 | .910 |
| Duration - average duration of unplanned events (controlled for principals) | .836 | -.320 |
| Complexity - complexity of unplanned events (controlled for principals) | .798 | .355 |
| Clusteredness - Gini coef. of unplanned events (controlled for principals) | -.672 | -.466 |

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
Rotation converged in 3 iterations.

## TABLE 3: Descriptive Summary and Correlations

| | | Mean | Standard deviation | N | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Performance (Percentage of good use of time) | .8693 | .1705 | 876 | | | | | | | | | | |
| 2 | Performance_controlled for principal | .0000 | .1160 | 876 | .680** | | | | | | | | | |
| 3 | Frequency | 5.9555 | 5.5637 | 876 | -.185** | -.093** | | | | | | | | |
| 4 | Duration | 33.4891 | 24.5446 | 876 | -.183** | -.147** | -.203** | | | | | | | |
| 5 | Complexity | 3.6108 | 1.1009 | 876 | -.174** | -.139** | .293** | .378** | | | | | | |
| 6 | Clusteredness | .3524 | .2863 | 876 | .117** | .102** | -.338** | -.255** | -.633** | | | | | |
| 7 | Environmental challenge | 64.5926 | 17.8159 | 646 | -.015 | .000 | .016 | -.039 | -.106** | .090* | | | | |
| 8 | Environmental turbulence | 29.9425 | 22.7645 | 638 | .049 | .000 | .061 | -.035 | -.032 | -.026 | .088* | | | |
| 9 | Individual experience | 5.0427 | 4.5961 | 445 | -.030 | .000 | .047 | -.121* | -.047 | -.029 | -.270** | -.251** | | |
| 10 | Individual effort | 539.1861 | 135.7930 | 876 | .003 | -.016 | .202** | .098** | .153** | -.148** | .054 | .002 | -.120* | |
| 11 | School level (elementary = 0, other = 1) | .3699 | .4830 | 876 | .024 | .000 | .082* | -.034 | -.097** | .029 | -.119** | .228** | -.141** | .098** |

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

## TABLE 4: Tests of Interaction Effects of Environmental Challenge

| | Model 1 | Model 2 | Model 3 |
|---|---|---|---|
| Zscore: Frequency | -.219** | -.219** | -.217** |
| Zscore: Duration | -.180** | -.180** | -.163** |
| Zscore: Complexity | .026 | .025 | -.001 |
| Zscore: Clusteredness | .008 | .008 | .013 |
| Zscore: Environmental challenge | | -.002 | .008* |
| (Zscore: Frequency) x (Zscore: Environmental challenge) | | | .052 |
| (Zscore: Duration) x (Zscore: Environmental challenge) | | | .082 |
| (Zscore: Complexity) x (Zscore: Environmental challenge) | | | .034 |
| (Zscore: Clusteredness) x (Zscore: Environmental challenge) | | | .025 |
| $\Delta R^2$ | .050** | .000 | .010 |
| N (Sample size) | | 646 | |

** Coefficient is significant at the 0.01 level (2-tailed).
* Coefficient is significant at the 0.05 level (2-tailed).

## TABLE 5: Tests of Interaction Effects of Environmental Turbulence

| | Model 4 | Model 5 | Model 6 |
|---|---|---|---|
| Zscore: Frequency | -.219** | -.220** | -.192** |
| Zscore: Duration | -.181** | -.181** | -.122* |
| Zscore: Complexity | .026 | .026 | -.004 |
| Zscore: Clusteredness | .008 | .008 | .011 |
| Zscore: Environmental turbulence | | .007 | -.013 |
| (Zscore: Frequency) x (Zscore: Environmental turbulence) | | | .044 |
| (Zscore: Duration) x (Zscore: Environmental turbulence) | | | .217** |
| (Zscore: Complexity) x (Zscore: Environmental turbulence) | | | -.136 |
| (Zscore: Clusteredness) x (Zscore: Environmental turbulence) | | | -.060 |
| $\Delta R^2$ | .050** | .000 | .016* |
| N (Sample size) | | 638 | |

** Coefficient is significant at the 0.01 level (2-tailed).
* Coefficient is significant at the 0.05 level (2-tailed).

**TABLE 6: Tests of Interaction Effects of Individual Experience**

| | Model 7 | Model 8 | Model 9 |
|---|---|---|---|
| Zscore: Frequency | -.152* | -.152* | -.157* |
| Zscore: Duration | -.082 | -.082 | -.083 |
| Zscore: Complexity | -.024 | -.024 | -.026 |
| Zscore: Clusteredness | .004 | .004 | -.002 |
| Zscore: Individual experience | | -.004 | .014 |
| (Zscore: Frequency) x (Zscore: Individual experience) | | | .017 |
| (Zscore: Duration) x (Zscore: Individual experience) | | | -.022 |
| (Zscore: Complexity) x (Zscore: Individual experience) | | | .053 |
| (Zscore: Clusteredness) x (Zscore: Individual experience) | | | .062 |
| $\Delta R^2$ | .030* | .000 | .003 |
| N (Sample size) | | 445 | |

** Coefficient is significant at the 0.01 level (2-tailed).
* Coefficient is significant at the 0.05 level (2-tailed).

**TABLE 7: Tests of Interaction Effects of Individual Effort**

| | Model 10 | Model 11 | Model 12 |
|---|---|---|---|
| Zscore: Frequency | -.110** | -.116** | -.136** |
| Zscore: Duration | -.150** | -.154** | -.154** |
| Zscore: Complexity | -.056 | -.057 | -.033 |
| Zscore: Clusteredness | -.009 | -.008 | -.011 |
| Zscore: Individual effort | | .030 | .038 |
| (Zscore: Frequency) x (Zscore: Individual effort) | | | .058 |
| (Zscore: Duration) x (Zscore: Individual effort) | | | .014 |
| (Zscore: Complexity) x (Zscore: Individual effort) | | | .078* |
| (Zscore: Clusteredness) x (Zscore: Individual effort) | | | .087* |
| $\Delta R^2$ | .039** | .001 | .009 |
| N (Sample size) | | 876 | |

** Coefficient is significant at the 0.01 level (2-tailed).
* Coefficient is significant at the 0.05 level (2-tailed).

## TABLE 8: Summary of Hypotheses Testing

| Numbers of Hypotheses | Predictions | Results |
|---|---|---|
| 1 | Main effects of frequency (-), duration(-), complexity(-), and clusteredness (+) | Supported in correlations; partially supported in regression |
| 2 | Moderating effects of environmental challenge (-) | Not supported |
| 3 | Moderating effects of environmental turbulence (-) | Not supported |
| 4 | Moderating effects of individual experience (+) | Not supported |
| 5 | Moderating effects of individual effort (+) | Partially supported |

## TABLE 9: Tests of Interaction Effects of School Levels

| | Model 13 | Model 14 | Model 15 |
|---|---|---|---|
| Zscore: Frequency | -.110** | -.110** | -.148** |
| Zscore: Duration | -.150** | -.150** | -.160** |
| Zscore: Complexity | -.056 | -.056 | -.075 |
| Zscore: Clusteredness | -.009 | -.009 | -.033 |
| School level (elementary = 0, other = 1) | | -.001 | -.005 |
| (Zscore: Frequency) x (Zscore: School level) | | | .089* |
| (Zscore: Duration) x (Zscore: School level) | | | .142** |
| (Zscore: Complexity) x (Zscore: School level) | | | -.098* |
| (Zscore: Clusteredness) x (Zscore: School level) | | | -.083 |
| $\Delta R^2$ | .039** | .000 | .024** |
| N (Sample size) | | 876 | |

** Coefficient is significant at the 0.01 level (2-tailed).
* Coefficient is significant at the 0.05 level (2-tailed).
† Coefficient is significant at the 0.1 level (2-tailed).