12-2009

Interrupting the Workplace: Examining Stressors in an Information Technology Context

Pamela Galluch
Clemson University, pgalluc@clemson.edu

INTERRUPTING THE WORKPLACE: EXAMINING STRESSORS IN AN INFORMATION TECHNOLOGY CONTEXT

A Dissertation Presented to the Graduate School of Clemson University

By: **PAMELA SUZANNE GALLUCH**
December 2009

Submitted for the Partial Fulfillment
of the Requirements for the Degree
Doctor of Philosophy
College of Business and Behavioral Science
Management

Accepted by:
Dr. Varun Grover, Co-Chair
Dr. Jason Bennett Thatcher, Co-Chair
Dr. Richard Pak
Dr. Kristin Scott

Abstract

This dissertation focuses on the negative and positive outcomes of information and communication technology (ICT) in facilitating and reducing stress. The goals of this dissertation are twofold: 1) to deepen our understanding of how ICT-enabled interruptions influence individuals' episodic stress and 2) to examine whether ICTs may also be used to diminish stress evoked by ICT-enabled interruptions. Originating from psychology, *the demands control model* (Karasek, 1979) is used as an overarching theoretical lens to explain this technology-based duality, where technology serves as both a problem causing and a solution alleviating stress. The demands control model suggests that stressors have their greatest impact when control is low and demand stressors are high.

This dissertation examined three characteristics of demands: the quantity of the ICT-enabled interruptions (quantitative demand), the variability of the ICT-enabled interruptions (demand variability), and the profile of the message (confounding or cooperating). To understand how to mitigate demands' outcomes, we examined three moderators of the demand stressor/strain relationship: ICT-enabled timing control, ICT-enabled method control, and resource control. Applying these factors within the demands control model, we argued that control factors mitigate the effects of high demands on both stress and strain.

We tested our model using experimental design by administering two laboratory experiments. In doing so, we adopted a multi-method approach that uncovered how the body psychologically and physiologically reacts to ICT-based stressors. To examine physiological outcomes, we used two advanced tools that non-invasively captured indicators of strain: 1) salivettes captured cortisol and alpha-amylase found in saliva and 2) blood pressure recorders captured blood pressure and pulse rate. Then, we validated Likert-type scales to supplement objective indicators of stress.

Our results indicated that strain was apparent when stress results from ICT-enabled stressors. In Experiment 1, we found that ICT-enabled interruption characteristics associated with demands served as stressors and led to perceptual stress (formed of perceptual overload, conflict, and ambiguity). We then found that ICT-enabled timing control negatively moderated the relationships between stressors and stress. Finally, our analysis revealed that perceptual overload positively led to strain, perceptual ambiguity partially led to strain, and perceptual conflict did not lead to strain.

In Experiment 2, we found that coping behaviors negatively moderated the relationships between stressors, stress, and strain. Specifically, we found support for overall coping when it came to objective strain; however, we found no support that coping was a moderator with perceptual strain. In terms of specific coping behaviors, we found support that resource control minimized objective strain, while ICT-enabled method control minimized perceived and objective strain. We then tested the simple slopes of the coping interactions with respect to alpha-amylase and found that resource control decreased strain entirely no matter what level of stress the individual felt, while ICT-enabled method control had to be enacted during high stress environments for it to be a coping behavior. Further, if ICT-enabled method control was enacted in low stress environments; it could actually change form and become a stressor.

Our results have implications for research, method, and practice. First, we articulated a novel model of interruption-based stress and laid the foundation for understanding how ICT use creates feelings of strain and actual tension in individuals. Second, we were amongst the first to manipulate specific ICT-enabled antecedents of perceptual episodic stress. Third, we extended research on coping behaviors by objectively manipulating the enabling technology and examining the physiological changes that occur from their enactment. Finally, we extended our understanding of the relationship between ICT-enabled interruptions and objective strain.

Acknowledgements

I would acknowledge the considerable contributions of my two co-chairs, Dr. Varun Grover and Dr. Jason Thatcher. They both provided limitless advice and patience throughout my doctoral study. Their knowledge, beliefs, and experiences armed me with the tools I needed to push myself beyond what I believed imaginable and into true scholarship.

I would like to thank my committee member, Dr. Richard Pak, for his advice and support during the experimental portion of my study. This study would not have come together without his graciousness in allowing me to use his laboratory.

I would like to recognize my committee member, Dr. Kristin Scott, for her help, advice, and encouragement throughout this study.

I would like to thank my salivary assay company, Salimetrics, who provided very useful knowledge of stress hormones and their implications to my study. I am particularly grateful to Dr. Douglass Granger, who allowed me to gather his opinions on alpha-amylase.

I would like to acknowledge my fellow doctoral students who allowed me to use them as guinea pigs in the initial portion of the study. I am especially grateful to Nicholas Roberts for sharing doctoral study experiences.

I am grateful for my family for their love, devotion, and support.

Table of Contents

Page

List of Tables

Page

List of Figures

Page

Chapter 1. Introduction

1.1. Introduction

Sitting in a tiny cubicle, Johnny just received an assignment from his boss to write an important proposal for a new toy. It was midway through the work day, and he had a 5:00 p.m. deadline. He turned on his computer and opened Microsoft Word to start the proposal. However, as soon as he logged on, his instant messenger popped up with messages from his coworkers. "Do you know how to run queries in SQL?" "Did you hear about the change in management that is going to occur on July 3rd?" "What is the meaning of this memo Sally sent?" Along with his instant messages, he noticed he had a full inbox of e-mails to sort through.

The interruptions were getting in the way of his creativity and were intruding on his ability to think clearly about writing his proposal. "I heard about the job for the new toy. Did you consider a train that can talk?" "Do you think we should petition to wear jeans on Friday?" "Do you know why we have a mandatory meeting on Monday?" Three hours had gone by and he was just beginning to organize his thoughts on the proposal. He was getting frustrated by interruptions slowing his progress towards meeting his 5:00 p.m. deadline. Johnny hit his head with his hand—he felt stressed.

Johnny sat back and realized the interruptions were the problem with his lack of productivity. He turned off instant messenger and reset e-mail to download messages every 15 minutes. Lacking interruptions, Johnny started to craft his proposal. Finally, he was able to form a plan in his mind and complete his task.

Information and communication technologies (ICTs), such as email and instant messenger, are ubiquitous in organizational life. On the one hand, adopting new ICTs enables individuals to share information and accomplish work tasks more effectively. However, on the other hand, *implementing ICTs causes interruptions to arise at rapid rates in organizations.* By enabling more frequent communication and thus interruptions, ICTs' infusion in the workplace can lead to multiple outcomes ranging from positive outcomes (i.e., quicker task performance) to negative outcomes (i.e., higher levels of demand and stress).

This dissertation focuses on the negative and positive outcomes of ICTs in facilitating and reducing stress. Specifically, we examined whether ICTs induce and/or mitigate stress in individuals. First, we studied whether interruptions enabled by ICTs induce stress in individuals. For example, when many interruptions distract a worker, that worker may have to postpone completing an important task. This postponement reflects a deviation (or misfit) from the individual's goals to finish the assigned work, which then causes stress. Second, we examined whether technology-based solutions mitigate the influence of interruptions on individuals' work. For example, by increasing the amount of behavioral control individuals' have over ICTs, organizations may be able to help workers adjust to ICT-enabled interruptions more effectively. In this sense, technology acts as a double-edged sword by helping organizations progress through increased productivity, while hindering progress by creating stress, as in the case of ICT-enabled interruptions.

This chapter provides an overview of the literature on ICT-enabled interruptions and their relationship to stress and unfolds as follows. First, we explain the need for studying interruptions and stress. In doing so, we explain our focus on the short-term nature of interruptions. Next, we explain how interruptions enabled by ICT differ from conventional interruptions. Then, we develop our research questions and outline our general research model. Finally, this chapter concludes with an overview of the study's contributions to research, practice, and methodology.

1.2. Background and Motivation

ICT-enabled interruptions are becoming more pervasive in today's environment; therefore understanding the positive and negative effects of technology is important. First, we need to understand the negative effects of ICTs. Collectively, recent estimates suggest that ICT-enabled interruptions result in $650 billion per year in productivity losses for American organizations (Spira, 2007). However, indirect costs associated with returning from an interruption also occur. For example, estimates suggest that it takes workers approximately four minutes to reorient themselves to an original work task after an email interruption (Kessler, 2007). Other estimates suggest that following an interruption, 40 percent of workers fail to return to the original task they were working on prior to the disturbance (Thompson, 2005). Interruptions also have implications for long-term outcomes, such as increases in turnover through work exhaustion (a form of chronic stress) (Moore, 2000). To avoid work-related ICT-enabled interruptions, 46 percent of business leaders said they arrive at work early to get a head start before the masses tune in or log on (Keller, 2007). Overall, ICT-enabled interruptions have been shown to cause negative effects in individuals and thus decrease organizational productivity.

ICT-enabled interruptions are often referred to alongside of *technostress*. Technostress refers to any negative effect on human attitudes, thoughts, behavior, and psychology that directly or indirectly results from ICTs (Tu, Wang, & Shu, 2005; Weil & Rosen, 1997). Consistent with stress research, technostress is examined in terms of stressors and strain. Strain refers to the psychological and physiological responses individuals make to environmental demands (Perrewe & Ganster, 1989; Selye, 1956), and stressors refer to both the objective and perceived environmental demands (Perrewe et al., 1989). Characteristics of ICTs can be stressors that create technostress in individuals.

The episodic nature of stress is the most fundamental level of the stress phenomena and can shed light into ICT-enabled stressors. Episodic stress accounts for a more complete distinction of stressors, including the exact timing of the stressors and the frequency of an individual's exposure (Marin, Martin, Blackwell, Stetler, & Miller, 2007). This distinction has been shown to be a critical element in determining stress effects: stress elevates at the onset of the stressor and slowly decreases thereafter (Miller, Chen, & Zhou, 2007). Since ICT-enabled interruptions may sporadically disrupt an individual's work, we focused this study on the episodic level of analysis to understand how specific characteristics of the technology that are tied to the interruption can manifest into strain.

1.3. The ICT-Enabled Interruption

ICT-enabled interruptions are different from non-ICT/traditional interruptions in two main ways. First, ICT-enabled interruptions lack social presence. Second, ICT-enabled interruptions influence a finite workplace (i.e., the size of the computer screen) within the broader organizational environment.

First, ICT-enabled interruptions have less social presence than traditional interruptions because the cause of the disturbance need not be physically available to the interacting party. Social presence is the communicator's sense of awareness of the interacting partner's awareness (Gefen & Straub, 2004; Sproull & Kiesler, 1986). We argue that through social presence, ICT-enabled interruptions possess several characteristics that are distinct from traditional interruptions, including access, multiple senders, and cues. Due to the ease with which ICT-based interruptions can reach multiple individuals, they tend to be far more frequent than physical interruptions (Courtney, 2007). In addition to increased frequency, the lack of these interruptions' contextual cues manifest into negative outcomes, such as increased ambiguity and conflict with the individual's current workload (Chun, 2000). For example, the sender cannot attain strong contextual cues surrounding the recipient, such as acknowledging the recipient's amount of workload or determining whether the message is sent at an appropriate time. Therefore, contextual cues available through ICTs may not be as rich as those received in a traditional environment. Thus, negative outcomes, such as increased frequency, ambiguity, and conflict are more prevalent in an ICT environment.

Secondly, ICT-enabled interruptions arise on a technical workspace (i.e., computer screen). Technical workspaces are small, thus limiting the space available for ICT-enabled interruptions to occur alongside technical tasks. This is different from traditional oral interruptions, which do not necessarily interrupt an individual's direct workspace. Instead, ICT-enabled interruptions influence individuals through an already limited workplace, which directly intrudes on individuals' current ICT tasks. Therefore, because ICT-enabled interruptions must share a small workspace concurrently with the individual's primary task, they have a stronger negative impact on productivity than traditional interruptions.

Due to their potentially unique characteristics, we concluded that ICT-enabled interruptions are distinct from traditional interruptions because of their timing, frequency, cues, and finite intrusion space. Specifically, through the lack of social presence needed in ICT-enabled interruptions, individuals have greater access between parties, an increased number of senders to whom to respond, and decreased contextual cues. Furthermore, through the finite workspace, these factors have a stronger negative impact on productivity. For these reasons, ICT-enabled interruptions are distinct from traditional interruptions; therefore, in the current study, we seek to examine their unique relationship with episodic stress.

1.4. Research Questions

To build a deeper understanding of how ICT factors induce and reduce individuals' episodic stress, this study investigated how attributes of ICTs, the individual, and the interruption interact to produce stress in the workplace. Specifically, the research questions investigated in this study include the following:

- Do technology-enabled forms of interruptions create demands that lead to episodic stress?
- If so, do technology-enabled forms of control mitigate the effects of technology-enabled interruptions on episodic stress?

In the following sections, we provide an overview of this dissertation's research model, anticipated findings, and contributions.

1.5. General Research Model and Objectives

Originating from psychology, *the demands control model* (Karasek, 1979) is used as an overarching theoretical lens to explain ICTs' ability to create and mitigate stress. The demands control model suggests that ICT-enabled stressors have their greatest impact when personal control is low and job demand is high. However, stress from ICTs arises from the individual's appraisals of stressors during the stress process. Our model accounts for this process and suggests that the interaction between stressors and the ICT-enabled primary control influences stress and that the interaction between stress and coping behaviors (i.e., control over coping behaviors) influences strain. Because of the distinct relationship between demands and control, we further develop these concepts below as *the negative side of ICT-enabled interruptions (i.e., demands)* and *the positive side of ICT-enabled control (i.e., control)*. In doing so, we present the general research model used in this study as being framed by the demands control model (see Figure 1.1).

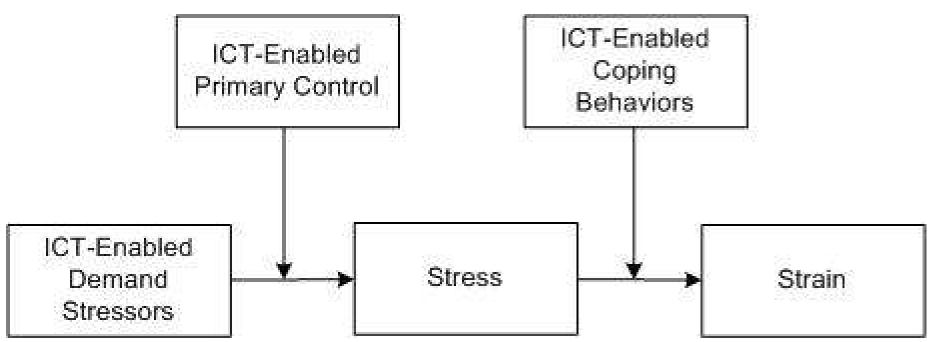


Figure 1-1 General Research Model

Table 1.1 provides definitions of the higher order variables to help convey the nature of the model before we proceed to the specific research objectives.

Table 1-1 Definitions of Components	
Key Stress Term	Definition
ICT-Enabled Demand Stressors	The objective demands that are enabled by ICTs and stress individuals (i.e., quantitative demand, demand variability, and message profile).
ICT-Enabled Primary Control	The initial level of control over the ICTs (i.e., timing control).
Stress	The feelings of overload, ambiguity, and conflict towards the demands and the forms of control in an environment.
ICT-Enabled Coping Behaviors	ICT-enabled behaviors enacted to attempt to alter, change, or escape from the stressors (i.e., method control and resource control).
Strain	Individuals' psychological and physiological responses caused by the fit between perceived stress and coping behaviors.

The specific research objectives of this study are outlined below:

- *To develop a model to explain how ICT creates and mitigates technostress.*
- *To test the theoretical model of technology-enabled episodic demands and control empirically.*

1.5.1. The Negative Side of ICT-Enabled Interruptions

When viewed through the lens of the demands control model, ICT-enabled interruptions lead to negative outcomes because they can produce ICT-enabled demand stressors. Specifically, ICTs can create stressors in three ways: high quantities of interruptions, high variability in the timing of interruptions, and conflicting message profiles within interruptions. Quantitative demand is characterized by the *amount* of ICT-enabled interruptions. Demand variability is characterized by the *consistency* with which an individual receives interruptions through the ICT. Message profile occurs within the interruption and is characterized by the level of *support* the content has in aiding the individual with completing his/her current work task. The message profile suggests that on-task messages cooperate with the individual's current demand to minimize his/her feelings of stress, while off-task messages conflict with the current demands by confounding his/her task-related priorities. Overall, these three factors evoke stress by influencing an individual's feelings of overload, ambiguity, and conflict. Perceptions of stress then influence objective indicators of strain (i.e., increased blood pressure, alpha-amylase, etc.), which completes the negative side of the transactional process— i.e., ICT-enabled demand stressors to stress to strain.

1.5.2. The Positive Side of ICT-Enabled Control

In this study, we examined two technological solutions and one nontechnical solution that function as moderators of ICT-enabled demand stressors-strain relationships: timing control, method control, and resource control. These moderators serve as mechanisms that potentially mitigate stress and therefore negative outcomes of demand stressors. Timing control occurs when individuals have control over *when* they choose to perform a behavior. Method control allows individuals to choose *how* they want to adjust to high demands by altering the way they work. Finally, resource control allows individuals to choose *where* to avoid demand stressors by enacting an option to become less active in and take a break from the ICT environment. In this sense, resource control allows individuals to cope by enabling them to move away from the ICT environment when stress is high.

While ICT-enabled interruptions may lead to negative outcomes, we suspected that their influence can be ameliorated by allowing individuals to have control over the timing of ICT-enabled interruptions and the use of coping behaviors. Timing control occurs alongside demands (i.e., it interacts with demand stressors to influence the initial level of stress), thereby placing it under the broad umbrella of *ICT-enabled primary* *control* in the general research model. ICT-enabled coping behaviors are formed of method control and resource control and are only enacted if the stressors are deemed harmful or threatening. Therefore, while the option of coping may be present within an environment, coping behaviors only reduce strain once enacted. Overall, these three control factors moderate demand factors at different stages of the stress process to minimize strain.

1.6. Research Design

To examine how ICT induces and ameliorates stress, we employed an experimental design. From the fields of psychology, health, and organizational behavior, we manipulated an enabling technology while using validated *objective and subjective measures of episodic stress/strain* to test the unique model of stress created by ICT-enabled interruptions.

First, we manipulated the enabling technology by examining objective indicators of ICT-enabled interruptions and ICT forms of control. In doing so, we built a research design that used experimental methods to incorporate various ICT components that influence stress. Through experimental design, we tested our model longitudinally by giving individuals control over the explicit timing of process of interruptions. Based on this research design, we explained variance and established causal relationships.

Second, we adopted a multi-method approach within the experiment that examined how the body physiologically and psychologically reacts to ICT-enabled interruptions. To examine physiological responses, we used two advanced tools that non-invasively measure strain: 1) salivettes, which capture salivary stress measures of cortisol and alpha-amylase and 2) blood pressure, which recorders capture both blood pressure and pulse rate. We followed the objective measures with psychological measures, thus providing us with a comparison between the objective indicators and the subjective measures of stress. This allowed us to test a process model of stress and make statements of causality that are often missing in Management Information Systems (MIS) and referent field research.

1.7. Contributions

This dissertation contributes to the MIS discipline by developing and testing a process-oriented model of how ICTs influence individuals' stress. By doing so, our work departed from previous MIS studies by using objective measures of strain. Specifically, we laid a foundation for MIS researchers to examine how different objective ICT characteristics and individual perceptions influence the stressor/strain relationship. We believe that our study can offer new avenues to MIS researchers (theoretically) on how objective technological characteristics can influence the stressor/strain relationship and (methodologically) in its use of objective strain metrics from best practices in health-related disciplines. Table 1-2 summarizes the contributions of this dissertation.

1.7.1 Contribution to Research

This study makes several contributions to research. Our first contribution was the formulation of a novel ICT-enabled model of interruption-based episodic stress. ICT-enabled interruptions are prominent in business (Keller, 2007), and their relationships to stress need to be explored in light of their varying characteristics. We have begun such research by focusing our model of stress on the episodic level. This level is the most fundamental form of stress, which makes it particularly useful in examining the ICT-enabled interruption context. This focus on ICT-enabled interruptions will lay the groundwork for researchers to advance our understanding of this pervasive phenomenon.

Secondly, in terms of theory, we presented a unique understanding of the demands control model by examining its relationship with technology to other theoretical perspectives. In this work, we bridged the cognitive (subjective) and epidemiological (objective) views on this topic by distinguishing and combining their insights to examine both the physiological and psychological impacts of ICT-enabled interruptions. We discovered that there was virtually a zero correlation between perceptions of strain and objective forms of strain and that while subjects had an increase to objective strain, the increase in the way they felt about the situation varied substantially. By contributing a focused interruption model of ICT-enabled episodic stress, we created a basis for understanding how ICT use can create feelings of strain and actual tension in individuals.

Third, this dissertation extends research on coping behaviors by manipulating enabling technology and examining the physiological changes that occur from the technologies' enactment. Therefore, we examined whether coping behaviors can also serve as stressors given different levels of stress. For example, we found that ICT-enabled method control can only serve as a coping behavior in high stress environments;

otherwise it could actually change form and become a stressor. However, resource control always reduced strain regardless of the individual's level of perceived stress.

Next, we examined what role messages within interruptions play in episodic stress. We profiled messages by categorizing their level of support in aiding the individual in finishing his/her primary tasks, while controlling for source. In doing so, we examined what type of support was given, whether it was on-task or off-task, and what relationship it had to stress. In our model, we examined message characteristics as conflicting and cooperating profiles. This view of message content as an aggregated profile is unique and ultimately sets the groundwork for examining additional profiles.

Finally, by relying on the demands control model as a theoretical tool, we used a novel approach to examine how characteristics of ICT-enabled control can mitigate the stress from interruption-based demands; that is, we present technological factors that overcome the interruption's impact on strain. By recognizing the negative side effects of technology alongside the benefits, we acknowledged a dual impact, where technology-based solutions offset technology-based problems.

1.7.2. Contribution to Methods

Along with our theoretical contributions, this study includes several contributions to methods. First, we documented the use of rigorous tools in the Information Systems (IS) context that clearly capture objective strain measures along with perceptions of stress. Specifically, we used non-invasive tools that explicitly capture how the use of ICTs impacts the stress hormone, cortisol; its precursor, alpha-amylase; and blood pressure. By examining these tools together, we presented IS researchers with superior ways of using these objective tools to measure stress.

This study also contributes by taking a multi-method approach that incorporates premiere stress/strain measures from multiple disciplines. This approach used experimental design to capture the stress process longitudinally. Therefore, rather than solely focusing on individuals, perceptions of ICTs, this study also manipulated actual characteristics of the enabling technology: we took the stress process all the way to objective forms of strain. By using experimental design guidelines that more accurately capture objective manifestations of strain, we were able to present best practices for inducing stress that will aid MIS researchers as we move forward with studying this phenomenon in the future.

1.7.3. Contribution to Practice

This study also provides several contributions to practice. First, the primary contribution of this dissertation is to identify technological characteristics that can be used to offset stressors in the workplace. Specifically, this dissertation increases our awareness of technostress by empirically examining the core contributors to episodic stress. Gaining a fundamental understanding of these issues is a first step in overcoming ICT-enabled interruptions. By understanding and limiting these workplace stressors, we hope that organizations can enhance the productivity and profitability of their employees.

Finally, this dissertation provides simple technological solutions to help reduce the negative outcomes of ICT-enabled interruptions and increase organizational productivity. Because chronic stressors only contribute to stress when paired with episodic stressors (Marin et al., 2007), we aimed to prescribe ways to mitigate both types of stress. Therefore, by examining the technological characteristics that offset episodic stressors, we prescribe ways to overcome the negative factors of ICT while still gleaning the intended benefits of technology.

Table 1-2 Summary of Contributions

Research Issue	Contribution
How do we study episodic stress in the context of ICT-enabled interruptions?	Research: This research formed a novel model of episodic stress related to ICT-enabled interruptions. Specifically, we provide specific guidelines on how technostress is manifested through stressors associated with interruption characteristics.
How do we examine content within ICT-enabled interruptions?	Research: This research examined how the messages within interruptions are profiled to effect episodic stress.
How do we bridge episodic stress theories through the study of ICTs?	Research: This research contributed a unique understanding of the demands control model by presenting its ICT-based relationships to other theoretical perspectives.
How can ICTs provide solutions to overcoming technostress?	Research: This research integrated many research streams to form a theory of ICT-enabled factors in which technology can serve as both the problem and solution of stress.
How can we capture variance in ICT factors through objective empirical methods?	Methods: This research presented the use of objective methods surrounding the ICT-enabled stress phenomenon to IS researchers.
How can IS researchers measure cortisol in the future with a non-invasive technique?	Methods: This research provided a detailed overview of the stress hormone cortisol and its precursor alpha-amylase so that IS researchers can use this method in the future.
How can organizations offset stress associated with ICT-enabled	Practice:

interruptions?	This research identified ICT-based tools that can be used to offset stressors in the workplace.
How can practice maximize the benefits from learning about ICT-enabled episodic stress?	Practice: This research provided directions to simple technological solutions to help reduce stress and increase organizational productivity.

1.8. Outline for Dissertation

This chapter provided an overview of our study, which is designed to test the relationship between technology use and stress. We introduced a process model that examines how technology and interruption characteristics work through stressors to create certain responses and outcomes of strain. By taking this process view of stress, we examined interruptions in the context of an ICT environment. In addition, we discussed how technology may mitigate the stressful influence of interruptions. Further, we briefly reviewed the experimental design used to test our process model. The chapter concluded with contributions to research, methods, and practice.

The next chapter presents the theoretical development underpinning our model of technology-enabled stress and understanding interruptions. We provide a detailed overview of stress research that spans from higher-order perspectives that house all stress research to more specific models of stress. Then, we present a typology of various sources of strain that have been examined in stress research. We conclude Chapter 2 with a discussion of theories that shed light on interruptions' influence within the information technology domain.

In Chapter 3, we present our formal research model and associated hypotheses. Chapter 4 spells out the proposed experimental design, sampling procedures, research tools, and analyses. Chapter 5 presents the research results, and Chapter 6 concludes the study with a discussion of our work's implications.

Chapter 2. Literature Review

2.1. Introduction

This chapter develops a model of stress that incorporates characteristics of ICT-enabled interruptions. To do this, we first reviewed two broad streams of stress research: cognitive and epidemiological. Rooted in this review, we examined perspectives for understanding stress as (1) a response, (2) a stimulus, (3) an interaction, or (4) a transaction. To select the most appropriate perspective for our study, we compared and contrasted their theoretical assumptions and implications. Based on this review, we argued that the transactional perspective is best suited for understanding how ICTs may create and ameliorate stress.

Next, under the broad umbrella of the transactional perspective, we reviewed three models that inform our research model, including the person-environment fit model, the cybernetic model of stress, control and coping, and the demands control model. We explained why the demands control model has the best potential for understanding technology – induced stress. We presented a variety of workplace stressors that can be examined in light of this model.

Finally, we defined the interruption and present interruption based theory that aids in combining the theoretical insights from the ICT-enabled interruption with stress literature. In doing so, we provided an interruption typology that will enable us to map its characteristics to appropriate stressors in an ICT-enabled model of stress.

2.2. Overview of Stress Research

As information technologies pervade the workplace, stress has become more apparent in organizational life, suggesting a growing relationship between information systems and stress in the workplace. In attempt to understand this prevailing negative workplace phenomenon, we gathered insights from the referent disciplines, including psychology, organizational behavior, and health, and bridged their work to what practitioner reports rave regarding information systems. Specifically, psychology literature informed our understanding of individuals' cognitive states and traits regarding stress. Organizational behavior literature shed light on the relationship of stress to job roles and characteristics. We assembled an understanding of the physiological outcomes of stress from literature in the health disciplines. Finally, we linked these theoretical insights to the technology-enabled interruption, which collectively allowed us to build a model that links technology to stress in the workplace i.e., technostress.

2.2.1. Epidemiological and Cognitive Views

Two views dominate stress research - epidemiological and cognitive. The epidemiological view links objective features of the environment to stress and strain. For example, epidemiological research has found links from objective measures of overload to negative physiological outcomes, such as increased serum cholesterol (Sales, 1969) even when subjects did not perceive themselves as overloaded. Because of the mismatch between perceptions and objective measures of stress, epidemiological researchers focus on tying objective characteristics of the environment to actual behaviors and physiological indicators of stress (Dwyer & Ganster, 1991).

The cognitive view examines ties from subjective appraisals of situational demands to stress and strain. Cognitive researchers argue that examining perceived control (subjective appraisal) is more important than examining objective conditions (i.e., behavior or physiological responses) (Glass, Reim, & Singer, 1971). In this sense, cognitive researchers believe that perceptions of a situation's impact on strain are more reliable than the objective measures of a situation (Perrewe et al., 1989). For example, in the demands control model, perceptual control interacts with demand stressors to create feelings of stress. To achieve a deeper understanding of stress and strain, cognitive researchers argue that "in order to truly understand the components of the stress process, we must include how individuals interpret objective conditions rather than simply relating stressors to strain" (Perrewe & Zellars, 1999 pp. 740). Therefore, cognitive researchers focus on the perceptions of the environment, rather than relying on objective indicators.

Many researchers root their work in either the cognitive or epidemiological view, failing to acknowledge the connection between the two research streams. This segregation has impeded progress towards understanding the stress phenomenon. Further, this has accelerated the rise of two distinct measures for the same conceptual stressors, which has resulted in contradictory findings. Due to this divergence, a debate regarding the appropriateness in using objective versus subjective indicators pervades the literature. This debate has caused the two modes to be examined concurrently through a mixed mode of reasoning. This allows researchers to grasp the deeper interplay between objective actions and subjective characteristics. In this sense, *there does not have to be a* *trade-off between objective and perceptual measures, but they can be holistically examined to provide a deeper level of understanding*.

Next, we evaluated perspectives on stress by tying them to these views, be it cognitive, epidemiological, or a mix. This enabled us to lay a foundation to examine information technology's links to stress and strain.

2.2.2. Theoretical Perspectives

The seminal work on stress originated from Seyle's (1956) strain model, which suggested that strain is created when individuals experience demand. Since then, stress researchers have adapted a number of perspectives, examining stress as a response, a stimulus, an interaction, or a transaction (Cooper, Dewe, & O'Driscoll, 2001). Table 2-1 presents these perspectives.

Table 2-1 Conceptualizations of Stress

Perspective	Focus	Definition of Stress
Response	Strain Outcomes	The common result of any demand upon the body: be the effect mental or somatic.
Stimulus	Stressor	Stress can be a list of responses and situations that fall under different definitions and headings.
Interaction	Stressor * Strain	Stress occurs from the interaction of the stressor and the response.
Transaction	Stressor –Stress – Strain	Stress is a dynamic cognitive state.

Definitions adapted from (Cooper et al., 2001)

2.2.2.1. The Response-Based Perspective

Consistent with the epidemiological view, response-based researchers conceptualize stress as a physiological response to threatening stressor. When individuals say, "I feel stressed" they are referring to the response or consequence of stress. In this view, stress refers to the "nonspecific (that is, common) result of any demand upon the body, be the effect mental or somatic" (Selye, 1993 pp. 7). Response-based stress research focuses on biological and psychological response to environmental demands (Selye, 1983). For example, stress causes wear and tear on the body, in which the body's response will *always* be the same regardless to changes in stressors (Stein & Cutler, 2001). Therefore, the outcomes of a stressful environment do not vary from individual to individual. Because individual differences do not matter in the response-based perspective, researchers understanding the responses to stress typically limit their focus to outcomes of stress.

The response-based perspective suggests the arousal of the autonomic nervous system results in two forms of stress: distress and eustress (Stein et al., 2001). Distress arises from negative reactions, and is the key factor in influencing illness. For example, a natural disaster can put a large number of people involved under distress, which results in both physical and mental strain. Eustress is positive stress, including facets like exercise, increased excitement, and learning. Eustress is related to sought-after encounters in a person's life, but can be just as easily taxing on the body if not controlled (Lazarus, 1993). For example, while short periods of increased physical arousal through exercise are good, prolonged continuous exercise can also lead to negative results i.e., increased fatigue and stress on the body. Lazarus (1993) found that eustress and distress could be broken up further and understood by emotion, where eustress includes feelings of happiness, pride, relief, hope, love, and compassion; and distress includes feelings of anger, anxiety, fright, guilt, shame, sadness, envy, jealousy, and disgust. Consistency of the negative feelings that coincide with distress leads to eventual illness.

Adapted from Stein and Cutler (Stein et al., 2001 pp.419), Figure 2-1 shows the conceptual process of how distress links to illness. While researchers acknowledge the process below, they only measure stress as outcomes, or the body's illnesses.

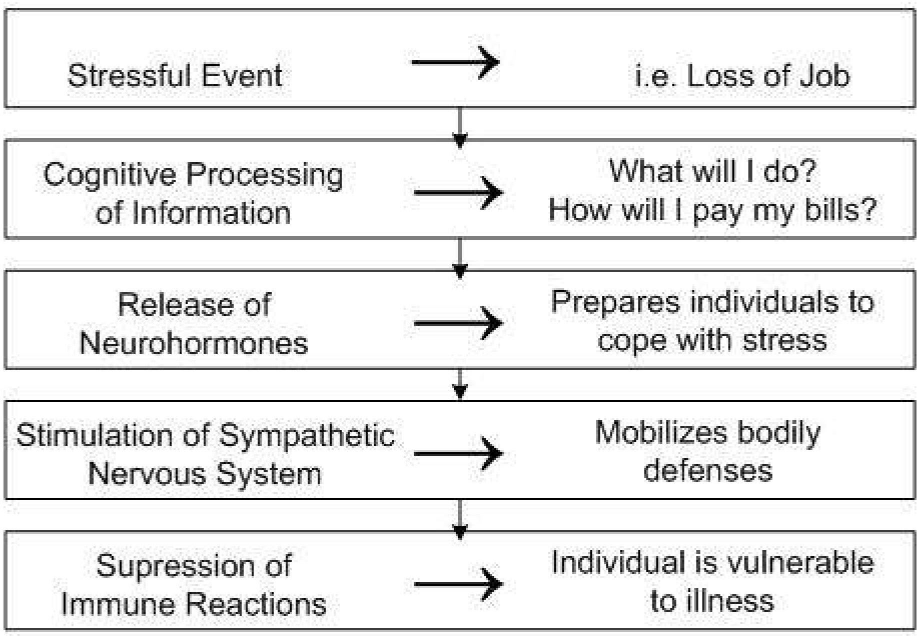


Figure 2-1 The link between stress and illness

2.2.2.2. The Stimulus-Based Perspective

In the stimulus-based perspective, stress, stressor, and stimuli are synonymously defined, which has also been termed "stress-as-stimulus" (Rice, 2000). Similar to response-based researchers, stimulus-based researchers also follow the epidemiological mode of thinking, but place more emphasis on the characteristics of the stressors that are influencing outcomes (Freedheim, Weiner, Velicer, Schinka, & Lerner, 2003). Specifically, stimulus-based researchers embrace the idea that stressors are *exerted* upon the individual, and that regardless of individual differences, stress is inherent in certain environmental events (Rice, 2000). When a stressor impinges upon the individual, the individual reacts to the stressor through actions (Cooper et al., 2001). For example, when an individual states that, "I am having a stressful time in this marriage," they are referring to the stressor, stress, and stimuli as one unified object i.e., the marriage. In this sense, stimulus-based researchers argue the stress process consists of two parts, stress and outcomes. Therefore, instead of grouping stressors by similar characteristics, stimulus-based researchers consider each environment as unique to determine an appropriate measure of stress. This is similar to response-based researchers, who contend that multiple aspects of the environment combine to form a stressful environment that cooperatively influences a variety of outcomes (Jansen & Kristof-Brown, 2006). However, unlike response -based researchers, stimulus-based researchers view all stress as having negative implications i.e., they focus on distress.

2.2.2.3. The Interaction-Based Perspective

The interaction-based perspective can follow either a cognitive or an epidemiological view depending on the specific research model. In the seminal piece, Kahn (1947, pp. 663) defined an interaction as a "recognition of the obvious and fundamental polarities in experience". In this approach, researchers focus on the interface between a subject and an object i.e., the individual and the environment (Kahn, 1947). Interaction-based researchers argue that no matter how divergent stress processes are the relationship between these two factors should remain constant. Also, by suggesting an interaction is present between the individual and the environment, this model considers the differences between individuals. Therefore, unlike the response and stimulus based models that consider stress as inherent, interactional stress models account for individual differences that influence stress (Smith, 2006).

2.2.2.4. The Transaction-Based Perspective

Whether using the epidemiological, the cognitive view, or a mixed view, transaction-based researchers argue that stress is not a factor of the individual nor the environment, but rather an embedded ongoing process that involves the individual transacting with their environment, making judgments, and coping with the issues that arise (Cooper et al., 2001). The transactional stress perspective is similar to the interactional stress perspective, except it considers exposure to frequency, severity, and duration of the stressful conditions as well as availability of stress reducing resources i.e., social support (Smith, 2006).

Transactional models imply a complex relationship between environmental variables, individual cognitions and stressors in their relationship (Daniels, 1994). In this perspective, each stressor is understood within the context of the stress process. Figure 2-2 depicts the transactional perspective of the stress process and Table 2-2 defines its components.

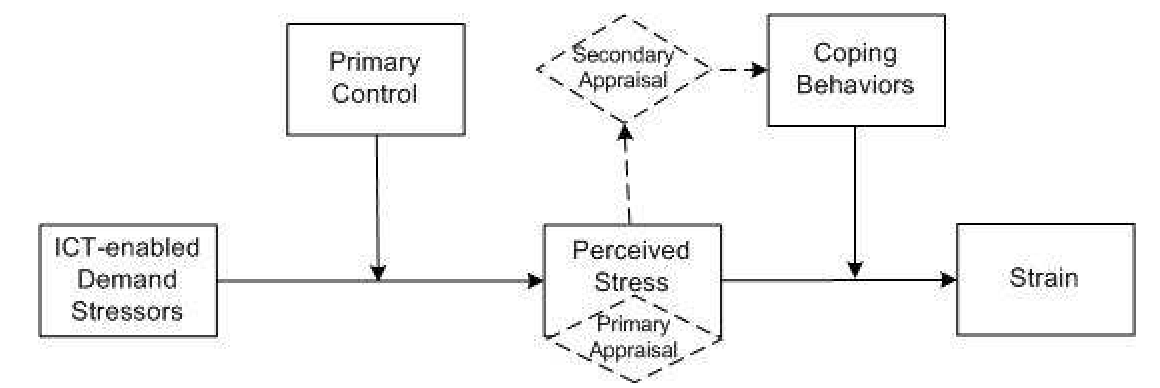


Figure 2-2 Transactional Model of Stress

Table 2-2 Definitions of the Components in the Transactional Perspective of Stress	
Key Stress Term	Definition
ICT-enabled Demand Stressors	The objective demands that are enabled by ICTs and stress individuals.
Primary Control	The initial level of control over the ICTs.
Primary Appraisal	An individual's appraisal of the motivational relevance of the stressors.
Perceived Stress	The feelings of overload, ambiguity, and conflict towards the demands and the forms of control in an environment.
Secondary Appraisal	An individual's beliefs of whether a change in ongoing conditions is perceived to be undesirable or desirable.
Coping Behaviors	ICT-enabled behaviors enacted to attempt to alter, change, or escape from the stressors.
Strain	The psychological and physiological responses made by individuals based on the fit between perceived stress and coping behaviors.

Transactional stress arises from both primary and secondary appraisal processes (Lazarus, 1994). Primary appraisal is the motivational relevance of the encounter with the stressor. During this appraisal, individuals ask themselves whether they have any personal stake in the encounter (Perrewe et al., 1999). Lazarus (1994) posited three primary evaluations at the onset of the stressor. First, is the stressor irrelevant and can it be ignored? Second, is the stressor benign but positive? Third, is the stressor harmful or threatening? If the stressor is appraised as harmful or threatening, the individual will engage in secondary appraisals within the stress process (Perrewe et al., 1999). Therefore, if the stressor is deemed stressful, the individual is perceiving stress through the evaluation of the primary appraisal.

The secondary appraisal refers to individual's beliefs of whether a change in ongoing conditions is perceived to be undesirable or desirable (Lazarus, 1994). This directly follows primary appraisals of stress and includes the individual's assessment of coping options (Cohen, 1984). Specifically, secondary appraisals are processes in which the individual evaluates existing coping options, the probability that a coping behavior will accomplish the desired outcome (i.e. to reduce stress), whether the individual has the capability to perform the associated coping behavior, and the consequences of the coping behavior (Lazarus & Folkman, 1984; Perrewe et al., 1999). Secondary appraisals span the evaluation period of secondary actions prior to enacting a behavior.

While secondary appraisals are evaluation of coping resources, coping corresponds to the actual behaviors. Specifically, "coping deals with the adaptational acts that an individual performs in response to disruptive events that occur in his/her environment" (Beaudry & Pinsonneault, 2005, pp. 494). By definition, the degree of perceptual stress evaluated during the primary appraisal does not influence the choice to enact coping behaviors. Instead, the individual must evaluate additional options during the secondary appraisal. Any additional behaviors added on once the environment was deemed non-stressful could not serve as coping behaviors. If the individual did not feel stressed during the primary appraisal, the individual would conclude that coping is not necessary in the secondary appraisal, and thus not cope. Alternatively, if the individual did feel stressed after the primary appraisal, the individual would cope. Therefore, if an individual's environment is changed by coping behaviors, their feelings of stress may be altered for the better to have less of an impact on strain (Lazarus, 1993).

Coping behaviors can be classified as problem solving or emotion focused. Problem solving coping is more often used in situations where the individual believes they have control over the situation (Folkman & Lazarus, 1980). If the individual perceives no ability or insufficient resources to change a situation, then they will use emotional focused coping. This type of coping effort will attempt to escape from the stressor (Folkman & Lazarus, 1985). While emotion focused coping avoids focusing on the stressor, problem solving coping alters the interpretation of the situation (Perrewe et al., 1999). Responses then depend on the fit between appraisals and coping (Lazarus et al., 1984).

2.2.2.5. Comparison of Theoretical Perspectives

Because the four perspectives focus on stress, they share several commonalities. First, each perspective incorporates a stressor, or encounter, that initiates stress. Second, all four perspectives include an outcome variable, whether objective as in the case of response and stimulus based perspectives, either cognitive or objective as in the interaction perspective, or a combination of cognitive and objective as in the transactional perspective. Table 2-3 compares the four perspectives.

While there are similarities, each perspective must also be considered in light of its limitations. First, the perspective of response-based stress has proven too limited for stress research because the definitions do not consider differences in stressors (Cooper et al., 2001). Because of this limitation, it has been shown to provide imperfect consistency while measuring actual manifestations of stress (Pearlin, Lieberman, Menaghan, & Mullan, 1981).

The stimulus-based perspective also has been shown to be limited in explaining the stress phenomenon (Cooper et al., 2001). First, typically stimulus-based researchers find the average stress over groups of people to arise at a single measure of stress instead of considering that many people can have many different perceptions about one event. In this sense, it limits its predictability by discarding individual differences (Cooper et al., 2001). Second, this perspective says little about the stress process itself. Instead of considering stressors separately from stress, it combines stressors and stress at the foundation of the stress process, and follows up by collecting potential effects and response outcomes at the end of the stress process (Rice, 2000).

The interaction perspective provides statistical reasoning; however, it is limited in predicting causality (Cooper et al., 2001). Also, the interactional approach does not consider exposure to frequency, severity, and duration of the stressful conditions or the availability of stress reducing resources (Smith, 2006).

Table 2-3 Comparison of Stress Perspectives				
Tenet	Response-Based Perspective	Stimulus-Based Perspective	Interaction Perspective	Transactional Perspective
Focus	Outcomes	Stressor	Stressor * Strain	Stressor – Stress – Strain
Mode	Epidemiological	Epidemiological	Epidemiological or Cognitive	Epidemiological and Cognitive
Individual vs. Inherent	Inherent	Inherent	Considers individual differences	Considers individual differences
Stress Definition	Static	Static	Interaction	Dynamic Process
Consistency in Definitions	Inconsistent	Inconsistent	Yes	Yes

Based on the limitations of the other three perspectives on stress, we adapt the transactional approach, which aids in understanding of the processes involved in the stressor – stress – strain relationships (Cooper et al., 2001; Lazarus & Cohen, 1977). This perspective can be adapted to the technological context and accounts for both cognitive (subjective) and epidemiological (objective) factors.

2.3. The Transactional Models

Within the theoretical domain, the transactional perspective is high level and may be conceptualized in lower level models. Table 2-4 presents three prominent models within the transactional perspective that inform our theoretical model. Our goal is to describe and compare models based on the transactional perspective. Then, based on our comparison, we determine the most appropriate model for understanding the influence of the technology-enabled interruptions on stress.

Table 2-4 Competing Models of Transactional Stress

Transactional Model	Stress Definition	Key Citations
Person-Environment Fit	Stress results from high demands or insufficient supplies to meet the person's needs.	(Edwards, 1996; Edwards & Cooper, 1988; Mayes & Ganster, 1988)
Cybernetic Model of Stress, Coping and Well-being	A temporal model of stress that results from the negative feedback loop between senses and responses.	(Cummings & Cooper, 1979; Edwards, 1992)
Demands Control Model	Stressors have their worst impact demands are high and control is low; however, an increase in control minimizes the negative effects of demands on strain.	(Demerouti, Bakker, Nachreiner, & Schaufeli, 2001; Dwyer et al., 1991; Edwards, 1996; Fox, Dwyer, & Ganster, 1993; Karasek, 1979; Perrewe et al., 1989; Salanova, Peiro, & Schaufeli, 2002)

2.3.1. Person-Environment Fit

The person-environment (P-E) fit model suggests that stress results from high demands or insufficient supplies to meet the person's needs (Edwards, 1996). Figure 2-3 depicts the P-E fit model adapted from (Harrison, 1978). The P-E fit model has been explained using many higher order perspectives such as person environment theory, the theory of work adjustment, and many other organizational theories (Roberts & Robins, 2004). Consequently, P-E fit models vary in their level of detail based on its theoretical insight. However, researchers using the P-E fit model are consistent on three vital components (Roberts et al., 2004). First, the person and the environment must be at the same level of analysis, where a person's characteristics fit with the attributes of the environment. Second, stress results from either a mismatch of one or both of two dimensions of the person with one or both of two dimensions of the environment: between *abilities* of a person and high *demands* or from the *values* of a person and insufficient *supplies* to meet the person's needs (Ayyagari, 2007; Cooper, 1998; Edwards, 1996; French, Caplan, &

Van Harrison, 1982). In this perspective, demands include quantitative and qualitative job requirements, role expectations, and group norms (Cooper, 1998). Abilities include individual aptitudes, skills, training, time, and energy to meet those demands. Needs are the biological and psychological requirements, values, and motives to accomplish a given task. Supplies refer to the resources and rewards that may fulfill an individual's needs (Harrison, 1978). Finally, this view is generally concerned with subjective appraisals of fit, i.e. individual perceptions of misfit between abilities and demands (Cooper et al., 2001). While P-E fit researchers agree the person and the environment include both objective and subjective characteristics of stress, the model depicts that the individual's subjective appraisal of the objective environment creates outcomes (Harrison, 1978). Therefore, such approaches accounting for the interconnection between objective and subjective measures of P-E fit have yet to be explored in the literature (Caplan, 1987).

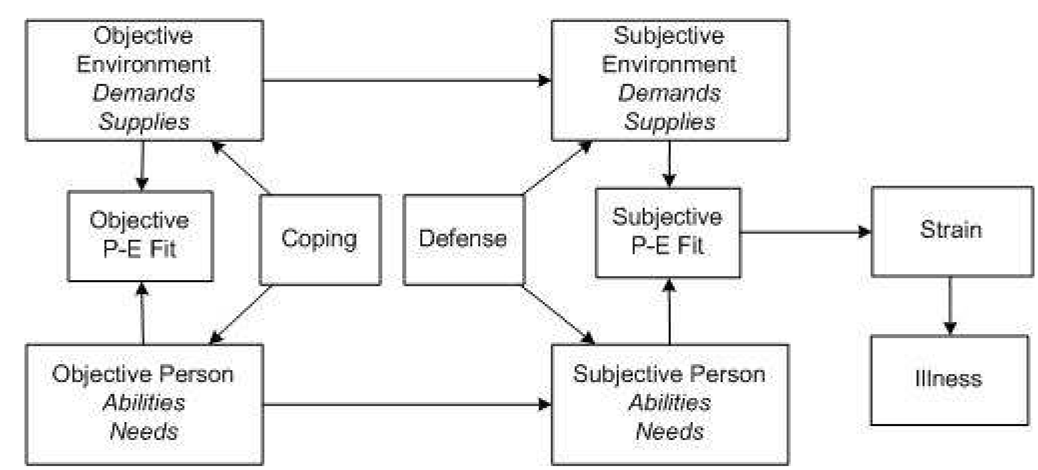


Figure 2-3 P-E Fit Model

2.3.2. Cybernetic Model of Stress, Coping and Well-being

The cybernetic model of stress, coping and well-being focuses on the processes involved in the determining stress (Cummings et al., 1979). Figure 2-4 depicts the cybernetic model adapted from Edwards (1992). In this model, particular attention is paid to the temporal nature of stress (Cooper et al., 2001). To understand stress, the cybernetic approach focuses on understanding causal relationships and the hierarchical arrangements among stress, the individual, and features of the environment (Carver & Scheier, 1982).

Cybernetic researchers argue that there is a negative feedback loop, in which an individual evaluates the current environment against established standards to determine if there is a deviation from their desired norm. In this sense, the cybernetic model focuses on discrepancies between two things: *current status* and *end states* (Edwards, 1992). These discrepancies influence two classes of outcomes, coping behaviors and well-being (Edwards, 1992). Coping behaviors refer to the efforts to prevent or reduce the negative effects of stress on well-being. Well-being refers to the psychological and physical health of the individual.

The cybernetic model is evident within the P-E fit model because both models focus on reducing deviations (or misfit) from a specific goal state, implementing coping behaviors, and determining outcomes (Edwards, 1992). Also similar to P-E fit models, cybernetic models are evaluated in terms of subjective appraisals (Edwards, 1992). However, the means to measure strain is different. In the cybernetic model, well-being is defined as the negative correlate to illness in the P-E fit model, which occurs as a result of strain. In this model, well-being is the proxy for strain as opposed to measuring strain directly as in the P-E fit model.

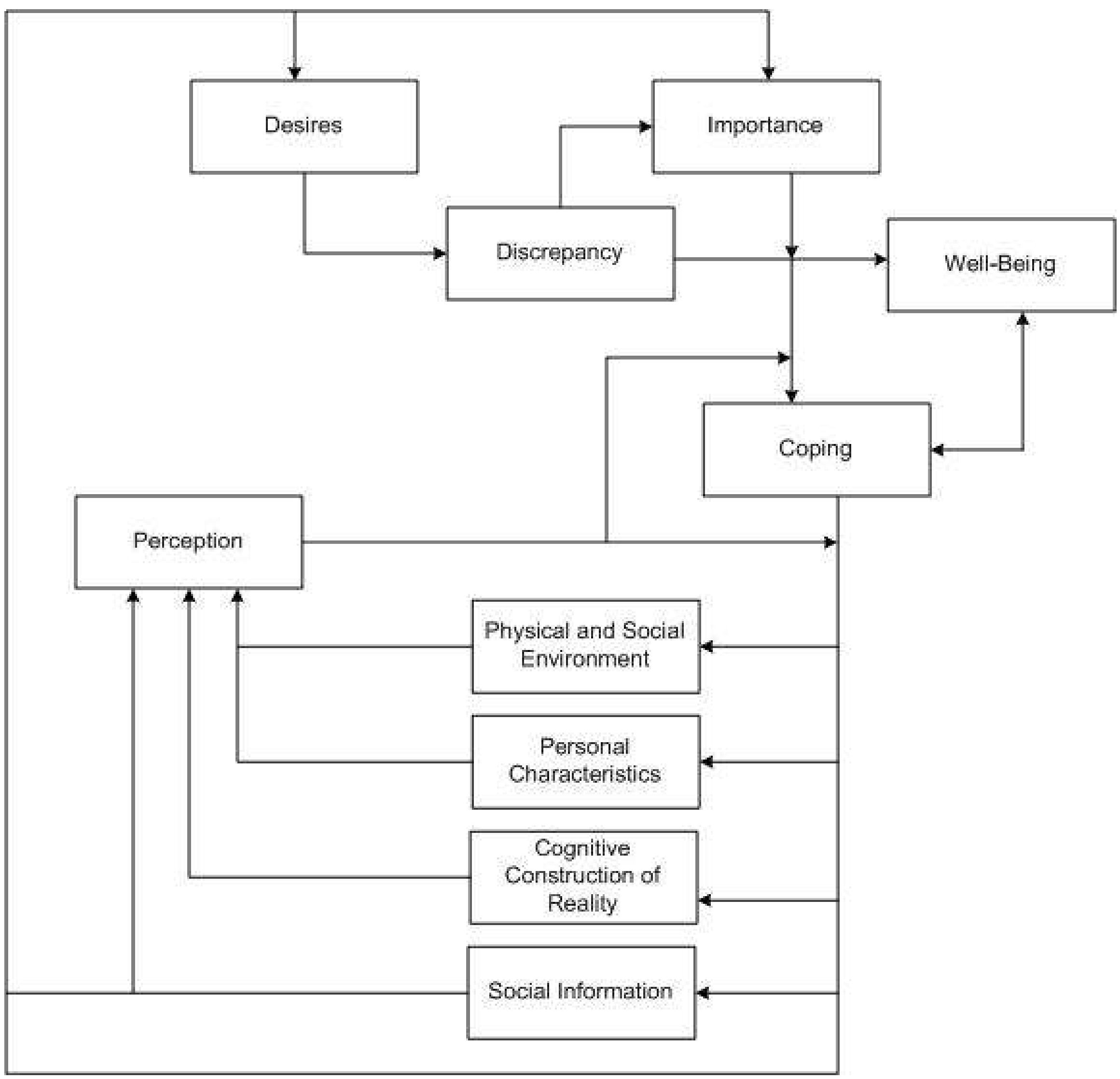


Figure 2-4 Cybernetic Model of Stress, Coping and Well-being

2.3.3. Demands Control Model

The demands control model posits that stress varies with psychological demand and personal control (de Jonge, Bosma, Peter, & Siegrist, 2000; Karasek, 1979). Figure 2-5 depicts the demands control model adapted from Karasek (1979) seminal work. Demand refers to the perceived and objective amount and type of workload (Mullarkey, Jackson, Wall, Wilson, & Grey-Taylor, 1997). Demand is determined by the amount and urgency associated with completing a group of tasks. Demand stressors directly relate to a degree of overload, because they correspond to measures of workload (Kirmeyer & Dougherty, 1988). Specifically, when workload is high, demands may exceed individuals' capabilities, which leads to feelings of overload (Kushnir & Melamed, 1991; Van Der Doef & Maes, 1999). For example, objective technological characteristics can create high demand by requiring individuals to complete many IT-based tasks given the allotted time period. Therefore, pressures that create stress arise from the need to overcome demand.

Personal control refers to the ability for individuals to determine a variety of behavioral elements, like method of working, the pace of work, and the work goals (de Jonge et al., 2000; Perrewe, 1987). Technology is designed to allow for varying levels of control and therefore provides solutions to accelerating demand. For example, emails that pop-up unexpectedly provide less control to individuals than clients in which the user chooses when to enact the behavior. In this example, control over timing through email clients helps mitigate the stress from high demand by allowing the user to organize their workload without unintentional interruptions.

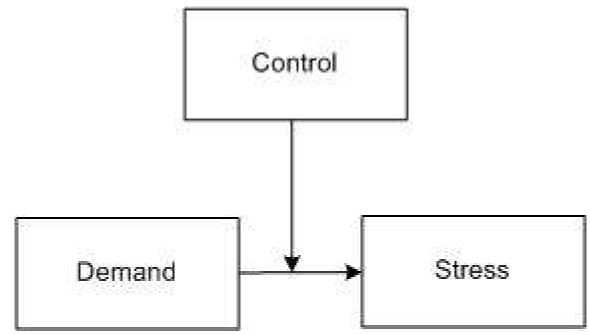


Figure 2-5 The Demands Control Model

The demands control model suggests that stressors have the most negative impact in high strain environments i.e., when control is low and demands are high (Schaubroeck & Merritt, 1997). However, an increase in control minimizes the effects of stressors on strain (Salanova et al., 2002). When both demands and control are high, the model indicates positive outcomes, such as increased motivation, learning, etc. (Karasek, 1979). This is considered an ‘active’ environment because while the positive environment creates stress, it creates eustress as opposed to distress. Eustress can arise from active environments because even though the demands are high, giving individuals control can lead to positive emotions, thus creating positive stress. On the opposite hand, when both control and demands are low, the environment is ‘passive’ and generally disheartening. It has been said that over time, the inactivity associated with this environment causes workers to lose the ability to make informed judgments, solve problems, or face challenges (Fox et al., 1993). Finally, when control is high and demands are low, the environment is considered ‘low-strain.’ This would be similar to a relaxed job, where workers can control their method and timing of their workload, while not being subject to constant interruptions. Figure 2-6 depicts the four environments that occur as a result of the interaction between demand and control.

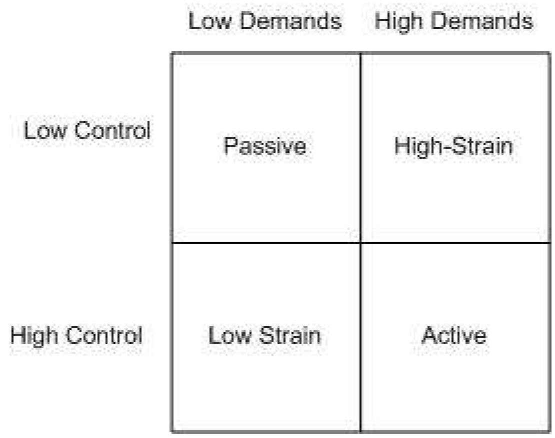


Figure 2-6 The Environments of the Demands Control Model

2.3.4. Comparisons of Transactional Models

The P-E fit model, the Cybernetic Model, and the Demands Control model have several common characteristics. First, they all model stress as part of a *dynamic process*. Second, they focus on the *negative encounters*, or the stressors, relationship with stress. In terms of the P-E fit model, this is embodied in the focus on stress as a function of misfit between abilities or values of an individual with demands and supplies to meet the person's needs. In the cybernetic model, stress results from the negative feedback loop between the individual's personal reference criteria and their current environment. In the demands control model, stress results from a misfit between demands and controls. Table 2-5 formally compares these models.

In light of the similarities, the models also have considerable differences. First, these models differ in their links to the epistemological and the cognitive mode. Cybernetic models of stress solely follow the cognitive mode relying on the subjective appraisal of individuals (Edwards, 1992). Similarly, even though P-E fit models are theoretically designed to account for objective indicators, P-E fit researchers heavily rely on the cognitive mode of thought (Caplan, 1987). The demands control model was the only model that has previously been adapted in light of both cognitive and objective manners (Cooper et al., 2001). Second, in terms of abstraction, cybernetics models and P-E fit models are more broadly situated in stress research than the demands control model, which is a more specific model. This is because instead of generally theorizing a model that can be adjusted to include all types of stressors, the demands control model focus on two specific constructs (demands and control). Because of an increased level of specificity, the demands control model is better for assessing episodic stress in individuals, where the P-E fit model is better for broader assessment of stress in an organizational context. Consequently, as researchers operationalize each model, during the translation to operational domain, several components of both the P-E fit model and the cybernetics model may begin to overlap more heavily with the demands control model depending on their research intentions.

Table 2-5 Competing Models of Transactional Stress

Transactional Models	**Person-Environment Fit**	**Cybernetic Model of Stress, Coping and Well-being**	**Demands Control Model**
Definition	Dynamic Process	Dynamic	Dynamic Process

		Process	
Models	Distress	Distress	Distress & Eustress
Encounter	Misfit	Negative feedback loop	Interaction of Stressors with Control
Mode of Influence	Cognitive - Subjective	Cognitive - Subjective	Cognitive and Epidemiological - Subjective and Objective
Level of Abstraction	Very High, and Inconsistent	High, difficult to capture	Low, with developed boundaries

Based on our formal comparison of the general research models above, we find that the demands control model yields both objective and subjective insights, has developed boundaries, and interacts with control factors that minimize stress. Therefore, we conclude that while the models overlap on several factors, the demands control model is the most appropriate to develop and test a research model of technology-enabled stress, which has yet to be examined in the literature.

Prior to developing our research model, the next section presents a typology of stressors and reviews various sources of strain that can be examined in light of demands and control. Then, we conclude the chapter by formally discussing the interruption and its relationship to the stress phenomenon.

2.4. The Sources of Workplace Stress

There are two general categories of stressors: chronic and episodic. A chronic stressor is a long-term, consistent or reoccurring pressure on one's life. Most of the literature has focused on chronic stressors to understand how they manifest long-term strain and decrease productivity. This category is chronic because the stressor is *constantly* stressing upon the individual's life (Beehr, Jex, Stacy, & Murray, 2000). Providing solutions for this group of stressors would imply altering one's life to attempt to fix the problem and then gauging whether the change has permanently removed the issue. Chronic stress studies examine stressors such as role characteristics (Beehr, Walsh, & Taber, 1976; Moore, 2000; Tarafdar, Tu, Ragu-Nathan, & Ragu-Nathan, 2007) or more specifically, work/family characteristics (Thomas & Ganster, 1995). For example, role characteristics point to both the uncertainty and incompatibility between behaviors and demands associated with the individual's role (Kahn, 1964). Work/family conflict is a role characteristic that refers to a type of conflict where work roles and family roles are incompatible (Hammer, Kossek, Zimmerman, & Daniels, 2007). These pressures are consistent in one's life and difficult to change, thereby serve as an ongoing, chronic, source of strain.

Researchers have also studied short-term or episodic stressors. An episodic stressor is a transitory negative event that occurs periodically but is not ongoing (Cooper et al., 2001). These stressors are categorized as acute or short-term stressors, and are labeled as episodic because they are *inconsistent* (i.e., sporadic) pressures in one's life (Beehr et al., 2000). Researchers study episodic stressors to understand how specific instances influence psychological symptoms. Episodic stress suggests that the stressor is an irregular action and varies in time based on the current situation between the individual and the environment. Consequently, researchers do not restrict timing of an episode because it must fluctuate according to the ongoing situation. For example, one study looked at the level of episodic stress associated with writing a graduation thesis, where the entire duration of the thesis process was considered the episode (Izawa et al., 2007). Others have categorized the episode as a *prolonged stressful experience* (Parkes, 1986), where the duration was not similar across episodes. Providing solutions at the episodic level would require the individual to gain an understanding of the stressors present and to build a case on how to control for this irregularity. This stressor does not require major life altering changes; however, the effects may have dramatic benefits on the individual's stress level. For example, by limiting episodic stressors in the workplace, one can mitigate both episodic and chronic stress. This is because episodic stressors have been shown to be the key factor in evaluating chronic stress, where chronic stressors were only found to be related to stress when paired with episodic stressors (Marin et al., 2007). Therefore, once episodic stressors are recognized, they are easier to control than chronic stressors and may also help minimize many harmful effects of chronic stressors.

After classifying stressors as chronic or episodic, the next objective is to describe specific workplace stressors that can be represented through a model of demands and control. After an exhaustive search of the literature, Table 2-6 presents a list of common workplace stressors examined in stress research and classifies them as chronic, episodic, or both.

Table 2-6 Common Workplace Stressors

Category	Classification	Stressor	Definition
Role Characteristics	Chronic	Overload*	Perceiving a lack of personal resources needed to fulfill commitments, obligations, or requirements.
		Ambiguity*	Perceptions surrounding the uncertainty of not knowing exactly what behavior are expected in one's job.
		Conflict*	Perceptions of incompatibility in the requirements of the role, where incompatibility is judged relative to a set of conditions that impinge upon performance.
Task Characteristics	Episodic	Work overload:	An individual's perception that they cannot perform a task because he/she lacks critical resources.
		Quantitative *	Limitations imposed by an individual's environment such as time or accessibility to a resource.
		Qualitative * Variability	Assigned work exceeding an individual's capability or skill level. Inconsistency in demand.
Job Characteristics	Chronic	Job Insecurity Work Hours	A perceived powerlessness to maintain desired continuity in a threatened job situation. The number of hours worked.
	Episodic & Chronic	Workplace Violence	The level of violence in the workplace.
		Temperature	The measure of the warmth of an individual's environment with reference to a standard value.
		Noise	The level of sound.
Support Characteristics	Episodic	Social Support:	A network of supervisors, subordinates, and coworkers that is available in times of need to provide help, whether financial, physical, or psychological.
		Instrumental Support*	Available aid from a relationship or network of relationships
	Chronic / Episodic	Source	Supervisor or Subordinate or Coworker
		Emotional Support	Emotional seclusion or working alone. Lack of Appreciation.
Control Characteristics	Episodic	Lack of Control*	An individuals' belief in their lack of ability to change the environment.
* Note –These constructs will be adapted to our study.			

2.4.1. Role Characteristics

Roles refer to the consistent behaviors and demands that are associated with the job an individual performs (Kahn, 1964). Stress from roles can originate from either incompatible role structures or stressful tasks (Peterson et al., 1995). Role characteristics are defined in terms of role structure, which is a function of role overload, role ambiguity, and role conflict (Bedeian, Burke, & Moffett, 1988; Peterson et al., 1995; Pierce, Gardner, Dunham, & Cummings, 1993). Work tasks are defined separately in the next subsection as task characteristics as opposed to role characteristics.

Role overload refers to a lack of personal resources needed to fulfill commitments, obligations, or requirements (Peterson et al., 1995). Individuals experience overload when role requirements are consistently too high or there are too many roles for the individual to fill (Cooper et al., 2001). Role underload is the opposite extreme to role overload, which occurs when a *status inconstancy* between high job skills and low job roles creates role stress (Bacharach, Bamberger, & Mundell, 1993). Therefore, role overload occurs when an individual perceives either too much work to do in the given role or too many different roles to fulfill (Tarafdar et al., 2007) and role underload occurs when an individual perceives too low of class roles given their skill sets and education (Bacharach et al., 1993). In the middle of these extremes, when an individual has a steady workload, they neither experience overload or underload because the job role fits their needs and expectations (Pierce et al., 1993). When roles are accomplished at a steady pace, there is plenty of time to finish the duties of the job roles and the job roles are a good fit with the individual's status desire.

Role ambiguity occurs when individuals are uncertain about knowing exactly what behavior is expected in one's job (Kahn, 1964). Individuals can experience ambiguity when expectations of job roles are unclear. Non-ambiguous roles suggest that individuals can predict exceptions and prioritize what others expect them to accomplish on the job (Pierce et al., 1993; Rahim & Psenicka, 1996). When roles are clear, individuals experience less role stress.

Role conflict imposes an incompatibility or incongruence in the requirements of the role (Rizzo, House, & Lirtzman, 1970; Tarafdar et al., 2007). Individuals can experience conflict when expectations and demands are consistently incompatible and difficult to prioritize. Roles with little conflict suggest that the individual can fulfill the job requirements without upsetting others (Pierce et al., 1993). Four types of role conflict exist: intrasender, intersender, person-role, and inter-role conflict (Cooper et al., 2001). Intrasender role conflict occurs when a supervisor communicates expectations that are mutually incompatible with each other. Intersender role conflict occurs when two or more people communicate expectations that are incompatible. Person-role conflict occurs when an individual perceives a conflict between his or her own personal expectations and values and those of the organization in the work environment. Finally, inter-role conflict occurs when a person occupies two or more roles that may have conflicting expectations or requirements. For instance, inter-role conflict can arise from the incompatibility of the family role and the working role of the individual (Wharton & Erickson, 1993). This type of inter-role conflict is referred to as work/family conflict, or a type of conflict where work roles and family roles are incompatible (Hammer et al., 2007). Overall, when roles are in conflict with each other, individuals experience more role stress.

Role stressors, including role overload, role ambiguity, and role conflict, lead to decreases in performance and satisfaction, and more importantly, increases in strain (Jackson & Schuler, 1985; Kahn, 1964; Pierce et al., 1993; Zohar, 1997). Because roles are behaviors and demands that *consistently* inflict stress on the individual, extended amounts of roles characteristics lead to these outcomes only after prolonged periods of time (Kahn, 1964). Therefore, roles are chronic stressors whose effects increase with time of exposure (Parasuraman, Greenhaus, & Granrose, 1992).

2.4.2. Task Characteristics

In addition to role characteristics, task characteristics can also lead to stress through work overload. Work overload is an individual's perception that they cannot perform a task because they lack critical resources (Cooper et al., 2001). This differs from role overload discussed in 2.4.1. Role overload entails the chronic feelings of overload due to a job role. Work overload focuses on feelings of overload created during a specific episode i.e., while completing a task.

The most common types of work overload in the literature are quantitative workload and qualitative workload (Cooper et al., 2001). Others have also included insight on workload variability as factor of work overload (Beehr et al., 2000; Ganster, Fusilier, & Mayes, 1986). First, the quantity of work can induce overload (Peterson et al., 1995). This is referred to as quantitative overload, which occurs when time pressure and demands exceed the individual's capabilities and/or accessibility to resources. Second, tasks are associated with varying levels of complexity based on individual's limited knowledge capacity or bounded rationality. This type of task overload is referred to as qualitative overload, which occurs when the requirements of the task exceeds an individual's capability and/or skill level (Perrewe et al., 1989). Finally, workload variability refers to tasks being unevenly allocated over time, resulting in individuals switching between work overload and underload. Therefore, when workload is variable, individuals are forced to adjust from underload (which causes stress due to its lack of challenge) to overload (which causes stress due to its intensity) –collectively causing more stress than if individuals were to streamline the workload (Bacharach et al., 1993). Research on overload, including both quantitative, qualitative, and variability overload, has been shown to lead to multiple factors, such as role stress, emotional exhaustion, and burnout (Cooper et al., 2001; Cordes, Dougherty, & Blum, 1997; Maslach, Schaufeli, & Leiter, 2001; Peterson et al., 1995). Because work overload is associated with a specific task, which is an inconsistent encounter, work overload is an episodic stressor whose effects increase with at the onset of the stressor and decrease thereafter (Beehr et al., 2000).

2.4.3. Job Characteristics

Characteristics of the job include job insecurity, the number of hours worked, workplace violence, noise, and temperature. Job insecurity is "a perceived powerlessness to maintain desired continuity in a threatened job situation" (Greenhalgh & Rosenblatt, 1984 pp. 438). On the other hand, job security reflects the level of security an individual feels toward retaining their job and maintaining their pay. Job insecurity has been shown to increase stress and anxiety, turnover intentions, reduced satisfaction, and reduced commitment (Ashford, Lee, & Bobko, 1989; Cooper et al., 2001). Furthermore, job insecurity has consequences for reduced organizational effectiveness (Greenhalgh et al., 1984).

Work hours refer to the sheer number of hours worked in an organization associated with the work schedule. In a meta-analysis, the number of work hours has been significantly shown to affect the health of individuals (Sparks, Cooper, Fried, & Sharom, 1997). Because job insecurity and work hours show effects after extended periods of time versus just one single point in time, they are behaving as chronic stressors whose effects increase with time of exposure (Heaney, Israel, & House, 1994).

Workplace violence refers to any encounter involving direct assault (Neuman & Baron, 1998). Workplace violence has been receiving increased attention in the literature mainly due to its association with fatal outcomes (Hoel, Sparks, & Cooper, 2006). Violent acts can arise from three sources: from robberies, from individuals who have a legitimate right to be on the workplace premise, or from current employees (i.e. coworkers, subordinates, or supervisors) (California Occupational Safety and Health Administration, 1995). Research on workplace violence has been previously shown to lead to greater stress, lower satisfaction, increased turnover intentions, and an increased probability in bringing a weapon to work (Budd, Arvey, & Lawless, 1996). Violence is associated with the most stress the time of the encounter; however, over time, consistency in violent job roles may also serve as chronic stressors.

Characteristics of the job can also be physical in nature, such as temperature and noise. Temperature, or the measure of the warmth of an individual's environment with reference to a standard value, is another physical job characteristic that can lead to stress (Cooper et al., 2001). Noise is the level of sound in the workplace. While noise and temperature can be episodic in nature, exposure to consistent physical job characteristics has been negatively linked with a range of health effects such as hearing loss (Kryter, 1994), cardiac problems (Cuesdan et al., 1977), and absenteeism (Cohen, 1973). On the opposite hand, low levels of noise may buffer the negative impact of job stress upon satisfaction, well-being, and organizational commitment (Leather, Beale, & Sullivan, 2003).

2.4.4. Support Characteristics

Support characteristics arise from the social support literature, which includes the type of support and source of support. Social support refers to the network of supervisors, subordinates, and coworkers that is available when an individual needs help, be it financial, physical, or psychological (Rahim et al., 1996). Social support can arise from any combination of role support, personal support, goal clarity (i.e. reduced role ambiguity), work facilitation, and protection (Pierce et al., 1993). Based on the initiator of the support, social support can be categorized as chronic or episodic. For instance, role support can give way to chronic support because it has to do with the long term relationship (i.e., spouse). On the other hand, goal clarity may lead to episodic support because it deals with clarifying short terms goals.

Most social support literature is comprised of two broad types of support: emotional and instrumental (Beehr et al., 2000). Emotional support involves listening to another person and providing comfort. Instrumental support is characterized by *rendering tangible assistance* (Fenlason & Beehr, 1994). Therefore, instrumental support is administered through communication, such as aid in the form of advice or knowledge needed to complete a task (Beehr et al., 2000). An unsupportive workplace environment through a lack of instrumental or emotional support can lead to stress (Cohen & Wills, 1985).

Social support can also be categorized by source – who is providing the support (Kaufmann & Beehr, 1986). This suggests that who is providing the support can affect how effective the support is (Rook, 1984). Specifically, support can be provided by a number of relationships, i.e. supervisor, subordinate, or peer (i.e. family members and friends) (Rahim et al., 1996). Therefore, the individual receiving support has previously established and classified their relationship with the supporter providing the support.

Social support has been shown to buffer the impact of stressors on strain, suggesting social support moderates the relationship between demand stressors and strain (Van Der Doef et al., 1999). Also, when support and source combine, they can collectively influence the level of support provided in the environment (Fenlason et al., 1994). Therefore, a lack of a social supportive environment intensifies the stress process (Ganster et al., 1986).

2.4.5. Control Characteristics

The lack of control, can lead to stress. Personal control refers to an individuals' belief in his or her lack of ability to change the environment (Perrewe, 1987). Four modes of personal control are frequently evaluated in the literature: cognitive control, information control, retrospective control, and behavioral control (see Table 2-7) (Thompson, 1981).

Cognitive control is the belief that one can ignore or distract themselves from an episode. Cognitive control is concerned with the subjective appraisal of situational demands that determine psychological impact on the individual. Following this view, control is a cognitive phenomenon, suggesting that individuals who perceive themselves in control have a higher tolerance to aversive events (Miller, 1979). Information control refers to the control over anticipating events, such as understanding warning signals, having information about future sensations, having the information about future procedures, or having information about the causes of an event (Skinner, 1996). Retrospective control refers to the ability to have power over the after-effects of a stressful situation (Taylor, Lichtman, & Wood, 1984). This form of control works under the assumption that if the individual can control whom to attribute blame after an event, they can increase their coping ability. Behavioral control is the degree the individual has control over their behaviors and timing of their actions.

Table 2-7 Typology of Personal Control

Control	Definition	Key Findings

Cognitive Control	The belief that one can ignore or distract themselves from an episode.	Cognitive control limits reactivity to aversive stimuli, which increases the ability to cope with aversive events (Fuller, Endress, & Johnson, 1978). In a study of the beliefs about control and adjustment over cancer found that cognitive control was most strongly associated with adjustment, behavior control was less strongly associated with adjustment, and information control and retrospective control were unassociated with adjustment (Taylor et al., 1984).
Information Control	Control over anticipating events, such as understanding warning signals, having information about future sensations, having the information about future procedures, or having information about the causes of an event	Information control is a critical resource for mobilizing power during the purchasing of a product (Petttigrew, 1972). Information control helps consumers better match preferences, have increased knowledge, and make judgments that are more confident, however, increasing control can also create demand on processing resources that hurts customers (Ariely, 2000).
Retrospective Control	The ability to control the after-effects of a stressful situation.	We must differentiate between retrospective control over successes and failures. Retrospective control over success implies that both contingency and competence, which implies anticipated control over future outcomes. In contrast, retrospective control over bad outcomes can have several different meanings (Skinner, 1996).
Behavioral Control*	The degree the individual has control over their behaviors and timing of their actions.	The degree of behavioral control that an individual has over an aversive event minimizes the impact of that event (Weiss, 1968). High behavioral control lessened the impact of work overload on anxiety (Perrewe et al., 1989). Behavioral control results from primary control and coping behaviors (Lazarus et al., 1984).
*Note – This type of personal control will be examined in this study.		

2.4.5.1 Behavioral Control

Behavioral control can be categorized further into timing control, method control, and resource control (see Table 2-8). Timing control refers to whether the individual can decide when to carry out a given task rather than responding to the environment (Van

Yperen & Hagedoorn, 2003). Timing control requires predictability (Daniels, 1994), suggesting that when the environment is more predictable, the individual has more control over their time and behavior. Timing control suggests that the individual is in charge of their behavior's duration or timing (Thompson, 1981). Timing control occurs alongside the stressors, suggesting that when a stressor occurs i.e., an interruption, the individual will be predisposed to a level of timing control through the technology i.e., invasive vs. noninvasive interruption. The transactional model suggests that if control is acknowledged during the primary appraisal, the effects of the stressor may be lessened. Therefore, because timing control and demands interact to produce the *initial* level of felt stress, if timing control is acknowledged within the current environment in which stressors are present, the alternate stressors dealing with demand may prove to be either irrelevant or benign. In this sense, timing control provides solutions to current demands.

Method control focuses on the extent to which the individual can carry out the work their way rather than being told how to complete their work (Wall, Corbett, W., Jackson, & Martin, 1990). Method control allows individuals to make choices and decide upon the techniques they are to use to carry out their demands (Van Yperen et al., 2003). Specifically, when individuals are given a task with instructions, if no method control is available, they will always follow the prescribed method i.e., turn the key with their hand. However, if method control is available and the individual feels the need to adjust the way they are handling their work to cope with the current stress, then they will enact the option and change their method of working i.e., turn the key with a robotic arm. In this sense, high method control allows individuals to adjust for an increase in demand the way they want. Low method control does not allow the individual to enact the option to alter the way they work. Individuals have low method control when there is misfit between the environment and the individual's need to work differently (Caplan, 1987; Goodhue & Thompson, 1995; Roberts et al., 2004). The availability of method control is determined after the secondary appraisal in which the initial stressors have already been deemed harmful or threatening. Method control functions as a problem-based coping mechanism, in which the individual believes they have sufficient resources to change the situation (Perrewe et al., 1999). For example, one study found that problem-based coping was achieved by seeking additional information instead of relying on their mind as a source of information (Carver, Scheier, & Weintraub, 1989). In this sense, the use of method control is a problem solving coping technique that does not begin until after the individual feels stress to lessen the impact on strain.

Resource control refers to the individual's ability to take a break and perform one or more off-task activities to rejuvenate his or her focus. Like method control and unlike timing control, resource control is a function of the secondary appraisal, and therefore a coping behavior. However, resource control is emotion-based as opposed to problem-focused because it allows one to avoid the stressors for a brief period of time. Therefore, resource control captures the escape-avoidance form of emotion-based coping (Byrd O'Brien & DeLongis, 1996). While this has been examined as a maladaptive coping mechanism i.e., *fleeing the stressful situation* (Byrd O'Brien et al., 1996, pp. 804), in an attempt to understand if coping helps, this has also been theorized as an adaptive coping mechanism (Aldwin & Revenson, 1987). This may be considered adaptive coping because resource control accounts for rest periods needed during the workday. Rest periods enable carryover benefits that allow individuals to more easily handle upcoming demand, allowing them freedom to plan ahead (Edwards, 1996). When organizations build in a certain level of slack time, they encourage flexibility and increased creativity (Nohria & Gulati, 1996). Slack time allows employees to spend time on off-task activities that fulfill non-work values, thus reducing an overall level of strain (Edwards, 1996). Therefore, in terms of behavioral control, timing control is the *when* associated with the initial behaviors, method control is the *how* associated with a coping behavior, and resource control is associated with the *where* associated with a coping behavior.

Table 2-8 Typology of Behavioral Control

Type	Definition	Key Tenets
Timing Control	Control over the timing of a behavior.	Timing control is impossible without predictability Timing control interacts with demands to produces the initial level of felt stress.
Method Control	Control over the behavior's method.	Method control allows individuals to make choices and decide upon the techniques they are to use to carry out their demands. Method control is only enacted after the primary method is determined to be a misfit with the individual. Therefore method control is a coping behavior. Method control alters the current situation and therefore is problem-focused coping.
Resource Control	Control over using slack resources.	Resource control allows individuals to have slack resources and be able to enact them when needed. Resource control allows individuals to cope by removing themselves from the stressors for a brief period when stress is felt. Resource control allows individuals to avoid the stressors for a brief period of time and therefore is emotion-focused coping.

In a meta-analysis on autonomy in the workplace, high levels of control have been associated with high levels of job satisfaction, commitment, involvement, performance, and motivation and low levels of emotional distress, role stress, absenteeism, turnover, and physical symptoms (Spector, 1986). Thus, the lack personal control leads to strain (Daniels, 1994).

2.4.6. Summary

In this section, we first described that stressors could be either episodic or chronic in nature. Second, we grouped the stressors by their major characteristics into role, task, job, support, and control categories. We found that characteristics of the task and control function at the episodic level, while roles functioned at the chronic level. Job and support characteristics function at either the episodic or the chronic level depending on the specific characteristic. Episodic task characteristics include quantitative, qualitative, and variability stressors. Control characteristics can arise from a lack cognitive control, information control, retrospective control, and behavioral control. Episodic job characteristics include temperature, noise, and workplace violence, while chronic job characteristics include job insecurity and work hours. Episodic support characteristics include instrumental support, which comes from a certain source, while emotional support from a source is either chronic or episodic in nature.

In the next section, we define the interruption and present a typology that will enable us to integrate the technology-enabled interruption into a model of demand stressors and control.

2.5. Framing a Model of the ICT-Enabled Interruption

2.5.1. The Interruption

ICT-enabled interruptions are pervasive in the workplace and therefore are a central aspect to examine in framing our research model. An interruption refers to any distraction that shifts individuals' attention away from a current task and requires conscious effort to the original task (Damrad-Frye & Laird, 1989). Interruptions can be either internal or external (Fisher, 1998). In terms of internal interruptions, people have been shown to have frequent shifts in thought processes, most of which are unrelated to the current task (Fisher, 1998). Internal interruptions arise from within the individual and detract the individual's attention away from the external environment (Smallwood & Schooler, 2006). This includes mind wandering, spontaneously acknowledging cognitive events, day-dreams, or stimulating independent thought (Fisher, 1998).

External interruptions include any distraction outside the individual, such as mobile phone, faxes, email, etc. External interruptions have been examined as intrusions, distractions, discrepancies, or breaks in individuals attention (Jett & George, 2003). An intrusion is an unexpected encounter initiated by a person that interrupts the flow and continuity of an individual's work and brings that work to a temporary halt. Distractions are psychological reactions triggered by external stimuli or secondary activities that interrupt focused concentration on a primary task. Secondary activities can include any activity that added to the workload of the primary task that breaks the continuity of concentration i.e., interruptions that require additional cognitive processing.

Discrepancies are perceived inconsistencies or misfit between one's knowledge and expectations and one's immediate observations that are perceived to be relevant to both the task at hand and personal well-being (Okhuysen, 2001). Breaks are planned or spontaneous recesses from work on a task that interrupt the task's flow and continuity. An interruption can possess characteristics of intrusiveness, distractibility, and discrepancy (i.e., misfit). Breaks are separate from this grouping because they result from the individual's decision to be interrupted – instead of imposed upon the individual. Therefore, ICT-enabled interruptions may be categorized as intrusive interruptions, which may distract the individual's concentration, and may postpone completing their current goals.

Depending on the theoretical lens, interruptions have different implications. The theories and their relationship to interruptions are defined in Table 2-9. From a control theory approach, interruptions produce negative effects when they slow progress towards goals (Carver & Scheier, 1990). Interruptions have enough power to independently alter emotional states though the environmental events that disrupt both the individuals' own behavioral expectations and expectations (Mandler & Watson, 1966; Mullarkey et al., 1997). When demands are high, workers have the basic need to be free from interruptions (Mandler, 1975). Freedom from interruptions can allow workers to build up momentum and continuity with their task, which influences positive well-being (Mullarkey et al., 1997). This suggests that freedom from interruptions can serve as a pre-condition to experience continuity with the task. This continuous relationship has been also defined in terms of flow and cognitive absorption – common to information systems research

(Agarwal & Karahanna, 2000; Csikszentmihalyi, 1990). In high cognitive or demanding task environments, it is important for individuals to have control over their workload to be able to experience the momentum associated with feelings of flow.

In terms of attention theory, an interruption results in the shift in focus from one processing stream to another (McFarlane, 1997). Interruptions often generate additional thoughts long after the cause of the interruption ends (Beal, Weiss, Barros, & MacDermid, 2005). The theory of attention suggests that interruptions remove the ability for the individual to manage their own attention (McFarlane, 2002). This leads to stress because people's capacity to process information is limited and can be easily overloaded without control over multiple attention-based requirements (Meyer & Kieras, 1997). Specifically, by diverting an individual's attention, interruptions cause a decrease in performance of the post-interruption task due to greater mistakes and/or reductions in efficiency (Gillie & Broadbent, 1989). In order to cope with interruptions, individuals apply distinct sets of production rules simultaneously for executing the procedures of multiple tasks (Meyer et al., 1997). Therefore, when individuals have control or extra cues over the rules, they can offset the negative effects of interruptions.

Communication theory suggests that supportive interruptions are less intrusive and disruptive than unsupportive interruptions. Supportive interruptions mostly succeed in gaining individuals' attention in same sex groups, where dominance is less important (Smith-Lovin & Brody, 1989). For instance, in public speaking an interruption is supportive if it is on-task with the speaker, effectively requests for elaboration, or completes the speaker's thoughts (Smith-Lovin et al., 1989).

Table 2-9 Summary of Interruption Theory

Theory	Problematic?	Concentration?	Relationship to Stress?
Control Theory	The interruption is problematic because it disrupts goal progress.	The interruption breaks the concentration of the individual because it limits behavioral control.	The postponement of goal progress can lead to stress.
Attention Theory	The interruption is problematic because it disrupts the individual's attention.	The interruption breaks the concentration of the individual because it limits attention-based control.	The disruption in attention can lead to stress.
Communications Theory	The interruption is problematic when it is unsupportive.	N/A	Unsupportive interruptions can lead to stress.

Interruptions lead to frustration, helplessness, a change in task strategies, or increased dynamism in accomplishing the original task (Fisher, 1998). Similarly, decreases in performance have been shown to result in stress when interruptions are unpredictable and uncontrollable (Cohen, 1980). For example, in terms of timing, a study on driver distraction found that it was most problematic to interrupt the individual during the middle of the task (Monk, Boehm-Davis, & Trafton, 2004) – when startup and slowdown costs were highest. In terms of hierarchy, because managers are frequently interrupted, interruptions are more costly due to attention reallocation because they require precious time (Seshadri & Shapira, 2001). Overall, while the interruption has been viewed in multiple contexts, all findings seem to converge on three points: the interruption is problematic, breaks the concentration of the individual, and can lead to stress. Therefore, the next step is to further examine the interruption in a technology-enabled model of stress to determine *if* and *why* interruptions are causing negative outcomes.

2.5.2. The Level of Study

In framing our model of technostress around interruptions, we defined above two main types of stressors, episodic and chronic, where an episodic stressor is the sudden momentous negative event that occurs periodically and a chronic stressor is a consistent or reoccurring pressure on one's life. We argue that it is essential to study episodic stressors in an interruption-based model for three main reasons. First, they provide a more fundamental view that can be more easily controlled than chronic stressors in a workplace environment (Parkes, 1986). Secondly, episodic stressors have been shown to be the key factor in evaluating an increase in chronic stress, where chronic stressors were only found to be related to stress when paired with episodic stressors (Marin et al., 2007). Finally, since ICT enabled characteristics are episodic in nature, we argue that the responses and outcomes of technology-enabled interruptions result in instantaneous manifestations of stress, thus being key in the light of our research questions. Therefore, we focus our efforts on short-term episodic stressors because interruptions are a form of episodic stress. This allows us to frame an interruption-based study around the technology-enabled pressures that surround an individual in the organization and that collectively lead to technostress.

2.5.3 Episodic Demand

To understand the implications of ICT-enabled interruptions at the episodic level, we provide a deeper evaluation of the stressors in light of our interruption-based context. Specifically, we provide how the interruptions map to different forms of demand within a technology enabled setting. In terms of task characteristics, interruption-based tasks can create demand because technology has the power to increase the speed and frequency of the incoming interruptions. For example, additional demands can interrupt an individual during an episode, creating additional workload requirements (Speier, Valacich, & Vessey, 1999b). This is known as quantitative demand, which increases with the number of ICT-enabled interruptions. The inconsistency of receiving the ICT-enabled interruptions during an episode creates demand requirements because it limits the predictability needed to adjust to the incoming interruptions (Meyer et al., 1997). This variability in demand through a lack of control causes the individual to feel stressed because it intensifies the struggle to establish a continuous relationship with the task (McFarlane & Latorella, 2002). Qualitative demand, demand in which the individual lacks skill to complete the task creates a different type of demand outside the demand from the interruption. This logic stems from the exertion interruptions have upon the individual, where it requires little skill to retrieve an interruption that is automatically exerted. Therefore, we find that technology-enabled interruptions can create additional demand by increasing the quantity and variability of an individual's workload.

Support characteristics can also create demand within a technology-enabled episodic interruption environment. For instance, communication theory suggests that the interruption can be codified as supportive or unsupportive. Unsupportive interruptions are more intrusive and disruptive than supportive interruptions (Smith-Lovin et al., 1989). As with quantitative demand, in which the number of interruptions create demand, messages can be grouped within an episode to affect stress, where generally receiving messages of support during a task minimizes the negative effects towards stress.

Finally, in terms of job characteristics, certain technologies do create demands through noise by making the interruption more intrusive. For instance, instant messenger frequently alerts individuals through sound when new messages pop up. Therefore, interruptions not only have the capability to take over visual processing, but also audio processing, which increases the pressure in breaking the continuity with the task (McFarlane, 2002). Temperature and violence are outside the technological environment, and therefore outside the scope of this study.

2.5.4. Interruptions and Stress

Previously, IS researchers have focused their models of technostress on the perceptions of stress (i.e., role overload) and linked them to chronic outcomes (i.e., job satisfaction, organizational and continuance commitment (Ragu-Nathan, Tarafdar, Ragu-Nathan, & Tu, 2008). However, this linkage overlooks two fundamental parts to stress theory: the stressors that come before the stress, and the objective strain that comes after people feel stressed. In this dissertation, we repositioned previous researchers "stressors" as our perceptual stress, while further exploring possible objective ICT-enabled stressors that are more likely the true source of strain.Characteristics of role stress, including overload, ambiguity, and conflict, can be adapted to the episodic level and serve as components of perceptual stress. Therefore, instead of influencing a specific stress (i.e. role), the individual feels stress from the current episodic demand requirements. In this sense stress is formed of perceptual overload, ambiguity, and conflict (Parasuraman et al., 1992), where these situational dimensions substitute as proxies for stress (Carlson, 1999). Through the transactional model, certain stressors create stress by influencing one or more of these dimensions. In doing so, the stressors can unequally influence stress through by their relationship with the dimensions (Nygaard & Dahlstrom, 2002). Therefore, the dimensions do not have to be directly correlated with each other to form the level of felt stress.

Interruption based demands can give rise to feelings of overload when the individual receives too many additional demand requirements given the time (Speier et al., 1999b). Therefore, individuals experience overload when the requirements of the interruption-based environment are too high and there are too many interruptions for the individual to overcome. Similar to role overload, which functions at the chronic level, individuals experience episodic overload when individuals lack the personal resources needed to fulfill the demand requirements

Individuals can experience ambiguity when interruption-based based demands increase the uncertainty of not knowing exactly what behavior is expected (Meyer et al., 1997), whether due to the interruptions or the message within the interruption. Similar to role ambiguity, individuals experience episodic ambiguity when expectations of demand requirements are unclear. Non-ambiguous demands suggest that an individual can predict interruptions and prioritize what others expect them to accomplish on the job (Pierce et al., 1993; Rahim et al., 1996).

Individuals can experience conflict when interruption based demands are consistently incompatible and difficult to prioritize with the current demand. Therefore, conflict arises from interruptions when individuals perceive an incompatibility in the demand requirements, where interruption-based demand conflicts with task-based demand. Tasks with little conflict suggest that the individual can fulfill both requirements without upsetting others (Pierce et al., 1993). When individuals receive extra support, they have additional informational cues that help them process the current demand (Hopp, Smith, Clegg, & Heggestad, 2005). Therefore, by helping the individual fulfill the requirements, supportive messages can limit feelings of conflict.

2.5.5. Episodic Control - Primary and Coping

In terms of the control characteristics, features of technology can ameliorate the stress created by interruptions. Interruptions automatically limit control over an individual's behavior unless technology can offset the negative effect by extending control. For instance, an intrusive interruption that abruptly occurs within an episode may prevent the individual from enacting control over their behavior. However, the intrusive nature of ICT-enabled interruptions can be counteracted when individuals enact control over the ICT. Therefore, control is a solution to the interruption based demand stressors.

Within the demands control model, control can attenuate demand stressors through either primary or secondary appraisals, in which the initial level of control is determined from the primary appraisal which effects stress and the coping behavior is determined from the secondary appraisal that combines with the initial effect to create strain (Lazarus et al., 1984). ICT-enabled timing control is the result from the primary appraisal because it enables control alongside the ICT-enabled interruptions. Therefore, interruptions will be received in a more controlled manner when timing control is available to individuals. Method control and resource control are coping behaviors, because they are only enacted when users feel stress from high interruption-based demands. While timing control and method control are ICT-enabled, resource control is a general form of coping that removes the individual from the technological environment when stress from demand requirements is high. However, because the individual determines resource control, it reflects the second type of interruption, a controlled interruption, discussed in section 2.5.1. Therefore, while timing control and method control ameliorate stress from the first type of interruption, the intrusive interruption, resource control allows the individual to cause a controlled interruption in order to lessen the stress received from the current environment.

2.6. Summary

This section summarizes the key takeaways discussed in this chapter that are useful in developing the theoretical model in next chapter. These are presented in Table 2-10 along with key citations. First, contemporary researchers view stress as a transactional process, which suggests that individuals manifest strain by interacting in a stressful environment. In this case, stress cannot be attributed exclusively to either individual or environmental factors, but it stems from the interaction of the two. Second, we propose using the demands control model as an overarching framework for understanding the relationship between ICT-enabled interruptions and stress. Third, we reviewed stressors and identified those most salient for understanding. Finally, we concluded by defining interruptions and placing them within the framework of episodic stress.

Table 2-10 Summary of Findings

Finding	Key Citations
Present-day researchers view stress as a transactional process that suggests that the individual and the environmental transact together to manifest strain. Transactional stress arises from both primary and secondary appraisals. Primary appraisals lead to stress. Secondary appraisals lead to coping behaviors. Strain forms from the misfit between appraisals and coping.	(Cooper et al., 2001; Daniels, 1994; Lazarus, 1993; Lazarus, 1994; Lazarus et al., 1984; Perrewe et al., 1999; Smith, 2006)
The demands control model provides a framework for understanding the stress process, which says that stressors have the strongest impact when control is low and demand is high. However, an increase in control minimizes the negative effects of stressors on strain.	(de Jonge et al., 2000; Karasek, 1979; Kushnir et al., 1991; Perrewe, 1987; Perrewe et al., 1989; Van Der Doef et al., 1999)
ICT-enabled interruptions create demands that affect stress at the episodic level of analysis.	(Fisher, 1998; Gillie et al., 1989; McFarlane, 1997; Meyer et al., 1997; Speier et al., 1999b)
Review of existing stress literature has identified quantitative demand, demand variability, message profile as potential demand stressors for an ICT-enabled interruption context of study.	(Beehr et al., 2000; Cooper et al., 2001; Ganster et al., 1986; Perrewe et al., 1989; Peterson et al., 1995)
Review of existing stress literature has identified timing control, method control, and resource control as potential behavioral control factors that provide solutions to ICT-enabled interruptions.	(Edwards, 1996; Mullarkey et al., 1997; Perrewe, 1987; Thompson, 1981; Wall et al., 1990; Wall, Jackson, & Mullarkey, 1995; Wall, Jackson, Mullarkey, & Parker, 1996)

The next chapter uses the frameworks and typologies uncovered in this chapter to ground and present a specific model of stress within a technology context. Specifically, we examine the stressors as ICT-enabled characteristics of the interruption (quantitative demand and demand variability) and message characteristics that lie within interruptions (message profile). We also identify several solutions regarding technology-enabled control and coping behaviors, timing control, method control, and resource control. Applying these factors within the demands control model, we argue that control factors mitigate the effects of high demands on both stress and strain. Based on our findings a research model is developed and hypotheses are theorized.

Chapter 3. Theoretical Development

3.1. Introduction

The purpose of this chapter is to present our research model and associated hypotheses. First, we provide a general overview of our model to reiterate its underlying theory. Then, we find links between objective stressors, perceived stress, and objective strain. Finally, we hypothesize specific forms of information and communication technology (ICT)-enabled control and coping behaviors that negatively moderate the relationships between stressors, stress, and strain.

3.2. General Overview

We defined an interruption as any distraction that moves individuals' attention away from a task and requires conscious effort to return to that task (Damrad-Frye et al., 1989). Our model of demands and control focuses on interruptions that 1) are external to the individual, 2) are enabled by ICTs, and 3) have the capability to communicate a message. Figure 3-1 presents the general research model discussed in Chapters 1 and 2 and Table 3-1 defines its components.

Our research model is based on the premise that individuals have many forms of interruption-based demands to overcome in their environment when they are provided with varying forms of behavioral control (Karasek, 1979). We argue that ICT-enabled interruption characteristics serve as demand stressors that create perceived stress at the episodic level. Primary control refers to the given level of behavioral control in an environment. The interaction of primary control and stressors is evaluated at the primary appraisal, which equates to the initial level of felt stress. Perceived stress mediates the relationships between stressors and strain. Our model also accounts for specific forms of coping behaviors that negatively moderate the relationships between perceived stress and strain. Coping behaviors are enacted after the secondary appraisal, in which the individual changes their behaviors to help reduce the current stress level evaluated during the initial appraisal. Primary control alleviates the impact of the stressors, while coping behaviors are things you do to alleviate the impact of perceived stress. Stressors have the strongest influence on stress, and in turn strain, when primary control and coping behaviors are low and demands are high (Schaubroeck et al., 1997).

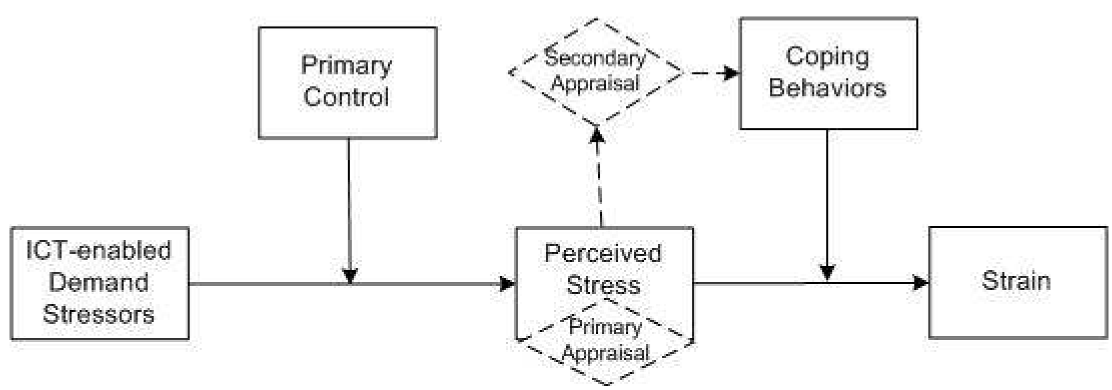


Figure 3-1 Transactional Model of Stress

Table 3-1 Definitions of Components

Key Stress Term	Definition
ICT-enabled Demand Stressors	The objective demands that are enabled by ICTs and stress individuals. (i.e., quantitative demand, demand variability, and message profile)

Primary Control	The initial level of control over the ICTs. (i.e., timing control)
Perceived Stress	The feelings of overload, ambiguity, and conflict towards the demands and the forms of control in an environment.
Coping Behaviors	ICT-enabled behaviors enacted to attempt to alter, change, or escape from the stressors. (i.e., method control and resource control)
Strain	The psychological and physiological responses made by individuals based on the fit between perceived stress and coping behaviors.

Once an individual enters an environment in which stressors and primary control are present, the individual automatically appraises the environment to determine the severity of the stressors. If the interaction between stressors and primary control is deemed harmful or threatening (i.e., stressful), the individual perceives stress when making primary appraisals. Alternately, if the interaction is benign (i.e., no motivational relevance to the individual), the individual will not be stressed. Therefore, when primary control is low and demands are high, the individual deems the environment stressful during the primary appraisal and the individual will feel stressed. This would cause the individual to evaluate coping options during a secondary appraisal.

When an individual's primary appraisal suggests that the environment is stressful, the individual will make a secondary appraisal to evaluate options in the environment and any alternate coping behaviors as a second form of control that could lessen the impact on strain (Lazarus et al., 1984). Secondary appraisals are processes in which the individual evaluates existing coping options, the probability that a coping behavior will accomplish the desired outcome (i.e., to reduce stress), whether the individual has the capability to perform the associated coping behavior, and the consequences of the coping behavior (Lazarus et al., 1984; Perrewe et al., 1999). If a secondary appraisal suggests a change is desirable, one engages in their second form of control, coping behaviors. While secondary appraisals are an evaluation of coping resources, *coping corresponds to the actual behaviors*. Therefore, if an individual's environment is changed by coping behaviors, their feelings of stress may be altered for the better to have less of an impact on strain (Lazarus, 1993). In this sense, primary control involves control over the stressors, while secondary control involves control over reducing the perceptions of stress.

Overall, when both demands and control are high, the model indicates positive outcomes, such as increased motivation and learning (Karasek, 1979). If positive outcomes occur from the environment, individuals will not perceive stress during the primary appraisal or be strained as a result of the secondary appraisal (Lazarus, 1993). When both control and demands are low, the environment is passive and generally disheartening, leading to increased boredom and possible frustration. Finally, when control is high and demands are low, the individual will not feel stressed or be strained.

3.3. Research Model

Our objective is to examine the transactional stress process in an ICT-enabled interruption context that occurs at the episodic level. An episode refers to a sudden momentous negative event that occurs when demand stressors appear sporadically to an individual. In this study, the episode includes two components: 1) ICT-enabled interruptions and 2) a primary task. Finishing the primary task represents the main goal of individuals. ICT-enabled interruptions serve as demand stressors because they prohibit individuals from finishing the primary task.

Our research model suggests that episodic demand stressors from ICT-enabled interruptions are formed by two facets - quantity and variability. Our model also accounts for a non-ICT demand stressor associated with the content of the message within the interruption by evaluating its profile's relationship with perceptual stress. We argue that ICT limits the positive influence ICT-enabled demands have on stress by enabling timing control. Finally, we evaluate an ICT-enabled coping behavior, method control, and a general coping behavior, resource control, that overcome the influence perceptual stress has on strain. Figure 3-2 presents the research model and associated hypotheses.

ICT-enabled interruptions are characterized by quantitative demand, demand variability, and message profile. Interruption-based quantitative demand refers to the number of ICT-enabled interruptions that occur during an episode. Interruption-based demand variability refers to the extent that the frequency of ICT-enabled interruptions remains constant rather than changing from low to high levels. ICT-enabled interruptions create stress through demand variability by creating uncertainty and overload in the scheduling and pacing of interruptions. Finally, the level of instrumental aid and the source of the aid interact to form the profile of a message (Beehr et al., 2000; Carlson & Perrewé, 1999). Specifically, message profile refers to the source and type of the instrumental pressure tied to each ICT-enabled interruption. In this sense, the message occurs within the interruption and either cooperates or conflicts with the current workload. These profiles affect stress at the episodic level, where generally receiving messages of support during a task minimizes the negative effects towards stress, while non-supportive messages positively influence stress. Overall, the three stressors, quantitative demand, demand variability, and message profile, create stress in individuals.

Stress is formed by three dimensions - overload, ambiguity, and conflict (Parasuraman et al., 1992). These three dimensions are situational factors that act as proxies for stress (Carlson, 1999). Through the transactional model, perceptual stress is a concept that is composed of its dimensions. The dimensions of perceptual stress have different antecedents, and influence varying levels of strain (Nygaard et al., 2002). For example, quantitative demand can influence overload by having a high number of interruptions place pressure on the individual. This stressor only influences overload and therefore has a zero relationship with ambiguity and conflict. In this example, the *pressure* equates to the level of felt stress created solely from quantitative demand. Therefore, the dimensions do not have to be directly correlated with each other to form the level of felt stress – as in a reflective construct.

Our research model follows the transactional process all the way to strain, which differs from perceived stress. Strain is the psychological and physiological responses of individuals to ICT-enabled demands (Selye, 1956). Strain occurs as a result of the interaction between coping behaviors and perceived stress (Lazarus et al., 1984). For example, if people perceive stress, their level of strain will increase. However, if people cope with those feelings, they can counteract the perceived stress, and lighten the influence on strain. When people refer to stress, they are sometimes referring to the entire transactional process (Cooper et al., 2001). However, *perceptual* stress is a specific part of the transactional process, which happens as a result of the stressors i.e., perceptions as a result of objective indicators. Other researchers equate perceived stress with the *primary appraisal* (Lazarus et al., 1977). As discussed in Chapter 2, we adopted this definition of stress. Strain results from perceptual stress, and must come after any secondary appraisals and coping behaviors (Cohen, 1984; Lazarus et al., 1984). Therefore, our transactional model focuses on the causal relationships among objective indicators (i.e., stressors), perceptual feelings (i.e., perceptual stress), and objective outcomes (i.e., strain), while interacting with primary control and coping behaviors.

In terms of the transactional model, the messages interrupt individuals via ICTs prior to the primary appraisal, in which primary control is also assessed. In this study, we examine timing control as a specific form of primary control. Because timing control is associated with primary control, it takes place at the same time the stressors are creating stress. Specifically, timing control refers to whether the individual has control over when they can check interruptions (Wall et al., 1990; Wall et al., 1995; Wall et al., 1996). For example, if an individual receives 10 messages from an ICT within 5 minutes, the options enabled through that same ICT will determine whether the messages will intrude on the individual's screen or stay in a mailbox until the individual actively chooses to view the messages. Overall, timing control offsets the stressors influence on perceptions of stress.

Coping behaviors can be classified as method control and resource control. Method control alters the interpretation of the situation, by changing the situation itself – i.e., changing the method to accomplish the task. Resource control will attempt to escape from the stressful environment i.e., avoiding the technology environment for a brief period. Coping techniques come after the initial level of stress because an individual will not enact the behavior until after evaluating the environment in a secondary appraisal. For example, if an individual feels stress from a high number of interruptions, resource control and method control help them cope with that stress by aiding them in achieving their goals associated with finishing the primary task. Because finishing the task is their primary goal, though coping, individuals are minimizing the stress's influence from the ICT-enabled interruptions on strain. This occurs through resource control by allowing individuals to clear any cognitive baggage that was disrupting their concentration on the task – i.e., avoiding the ICT-enabled interruptions. This occurs through method control by enabling individuals to streamline how they accomplish their task – i.e., making the task fit better with their methodological needs. Therefore, while method control uses resources to change the situation, resource control uses a different set of resources that enables them to avoid the situation.

While timing control and method control are ICT enabled, because resource control allows the individual to avoid the stressors, resource control is a general stressor that removes the individual from the technological environment when stress is high. Overall, timing control offsets the effect of *ICT-enabled* demand on perceptual stress, while method control and resource control offset the effect of perceptual stress on strain. Therefore, timing control only counteracts quantitative demand and demand variability, which are ICT-enabled, while method control and resource control counteract the initial level of stress to lesson strain.

Table 3-2 presents all the construct definitions to be evaluated in this study including strain, perceived stress, demand stressors, and control solutions.

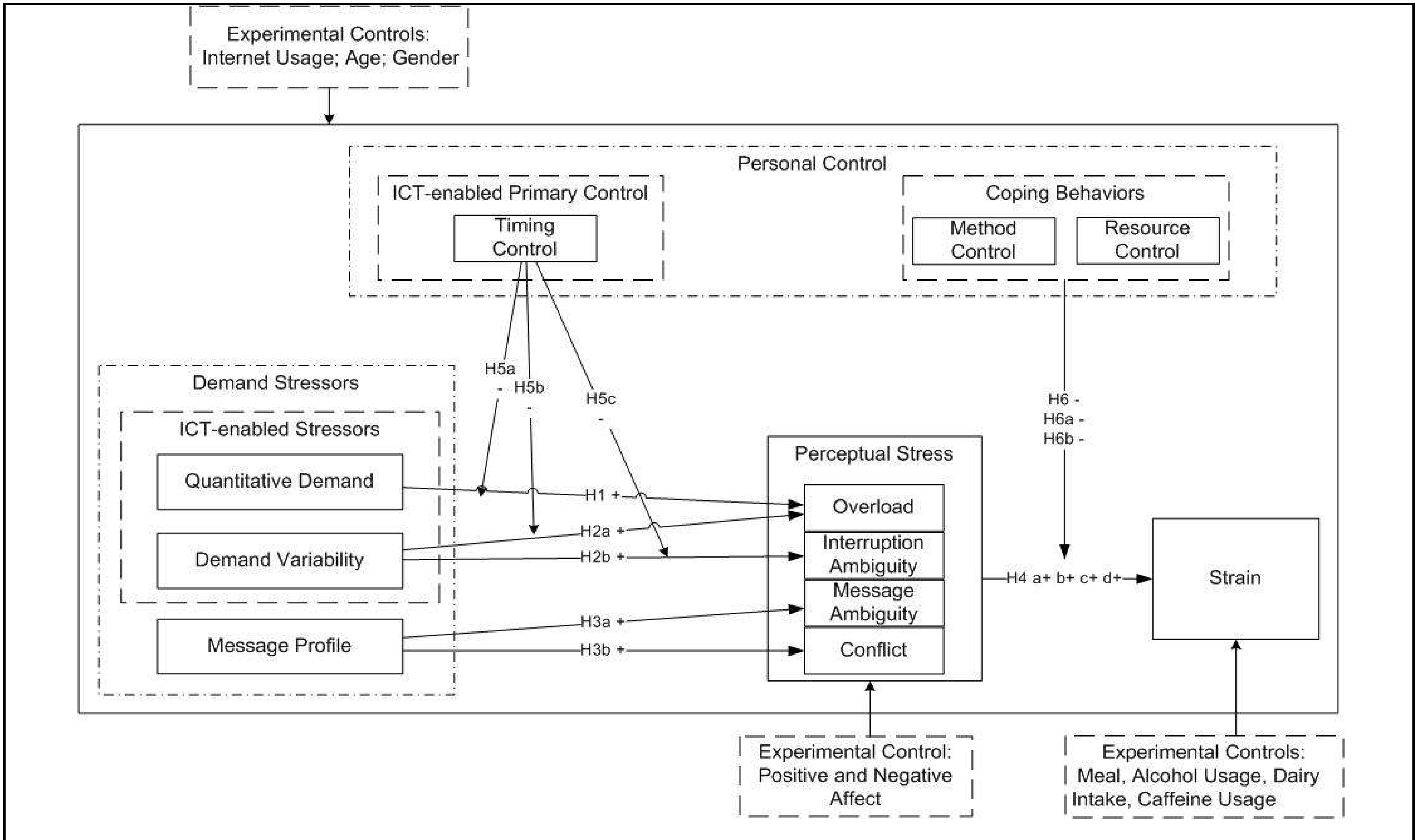


Figure 3-2 Formal Research Model

Table 3-2 Construct Definitions

Construct	Theoretical Definition	Context Specific Definitions	Key References
Strain	The psychological and physiological responses of individuals to environmental demands.	The psychological and physiological responses of individuals to ICT-enabled demands.	(Pearlin et al., 1981; Perrewe, 1987; Perrewe et al., 1989; Selye, 1956; Selye, 1983; Selye, 1993)
Perceptual Stress	Characteristics of an organizational role in which the individual perceives adverse consequences. Overload - Perceiving too much work to do in the given time period. Ambiguity - Perceptions surrounding the uncertainty of not knowing exactly what behavior is expected in one's job. Conflict - Perceptions of incompatibility in the requirements of the role, where incompatibility is judged relative to a set of conditions that impinge upon performance.	Characteristics of an ICT-enabled episode in which the individual perceives adverse consequences from the interruptions or the messages. Overload - Perceiving too many ICT-enabled interruptions given time period. Interruption Ambiguity – Feeling uncertain about the ICT-enabled interruptions. Message Ambiguity - Feeling uncertain about the message content within the interruptions. Conflict – Perceiving an incompatibility in the demand requirements, where the content of the message conflicts with task.	(Beehr et al., 1976 ; Kahn, 1964 ; Karasek, 1979 ; Perrewe, 1987; Perrewe et al., 1989; Rizzo et al., 1970; Toffier, 1981)
Quantitative Demand	The amount and type of workload.	The number of ICT-enabled interruptions.	(Kushnir et al., 1991; Maslach et al., 2001)
Demand Variability	The extent that the level of demand remains constant rather than changing from low to high levels.	The extent that the level of ICT-enabled interruptions remains constant rather than changing from low to high levels.	(Beehr et al., 2000; Edwards, 1996; Ganster et al., 1986)

Message Profile	Available aid from a relationship or network of relationships and the source of the instrumental (on-task/off-task) pressure.	The source and level of tangible aid of the instrumental pressure tied to each ICT-enabled interruption.	(Beehr et al., 2000; Carlson et al., 1999; Coyne & Downey, 1991; Daniels, 1994; Fenlason et al., 1994; Ganster et al., 1986; Kaufmann et al., 1986; Kirmeyer et al., 1988; Van Der Doef et al., 1999)
Timing Control	Whether the individual can decide and predict when to carry out given tasks.	Whether the individual can decide when to view messages, rather than responding to intruding ICTs.	(Mullarkey et al., 1997; Van Yperen et al., 2003; Wall et al., 1990; Wall et al., 1996; Wall, Kemp, Jackson, & Clegg, 1986)
Method Control	A coping technique in which the individual can chose how to carry out the work their way.	Enacting the option to control how to carry out the technology –based work.	(Mullarkey et al., 1997; Van Yperen et al., 2003; Wall et al., 1990; Wall et al., 1996; Wall et al., 1986)
Resource Control	A coping technique to avoid the stressor by acknowledging the option to become less active and relax from work stressors.	Enacting the option to relax from the ICT environment and engage in off-task behavior	(Dwyer et al., 1991; Edwards, 1996; Karasek, Russell, & Theorell, 1982; Landsbergis, 1988; Nohria et al., 1996; Yuan & Bieber, 2003)

3.4. Hypotheses Development

This section explains the logic behind the selection of, and relationships among, constructs. We begin by discussing the negative side of the model (the demand stressors – perceptual stress – to strain). Then, we discuss the positive side of the model (timing control and coping behaviors). We end by discussing the exploratory research examined in this study.

3.4.1. Demand Stressors

When individuals are working on a task in an organization, often they are continually interrupted, which creates more demand requirements for the individual to adhere to. Technology allows interruption-based demand to arise with higher levels of persistence than non-technology interruptions, which stresses the individual at different levels. Therefore, technology enables interruptions that serve as demand stressors in organizational environments.

This study will focus on two elements of demand that are characteristics of an ICT enabled – interruption environment (quantitative demand and demand variability) and one general form of demand (message profile). Because all three factors are episodic, they manifest instantaneous responses in stress levels by creating ambiguity, overload, and conflict. The justification for the relationships between the demand stressors and perceptual stress is presented in the following paragraphs.

3.4.1.1. Quantitative Demand

Quantitative demand is a task characteristic that refers to the amount and pace of workload (Dwyer et al., 1991; Perrewe et al., 1989). Quantitative demand is high when individuals do not have time to think or talk about anything other than the current task (Rugulies, Bultmann, Aust, & Burr, 2006). Quantitative demand is associated with low stress when the individuals experience moderate levels of interruptions as opposed to low levels. This is because low levels of quantitative demand can lead to inattentiveness, boredom, and performance decrements, which may also cause stress (Perrewe et al., 1989). This suggests that when quantitative demand is either low or high, stress occurs, while a moderate level of demand does not lead to feelings of stress. Empirical evaluation on this relationship between low quantitative demand and stress is limited. Consistent with past research, we limit this hypothesis development to understanding relationships derived from moderate and high levels of quantitative demand.

Quantitative demand has been examined objectively in many different contexts. For example, in a dentist office, demand was a function of the combination of working hours per week, the number of patients per day, the paramedical staff, and the number of dental chairs in the clinic (Tsutsumi, Umehara, Ono, & Kawakami, 2007). Other researchers use experimental design to examine demands' association with stress. For example, Perrewe (1989) used experimental design to examine quantitative demand, which was formed from the amount of physical card sorting. She found that perceptions of quantitative demand significantly affected stress. Overall, quantitative demand has been shown to be associated with stress (Maslach et al., 2001).

In this study, we focus on quantitative demand as the number of ICT-enabled interruptions that occur during an episode. While quantitative demand has been studied in face-to-face contexts, one may receive far more interruptions in a short period of time via ICTs such as instant messenger or e-mail. Given the quantity of ICT-enabled interruptions lack face-to-face social presence, a few interruptions may not be troubling, but a large volume of interruptions would be. The control theory of interruptions, presented in Chapter 2, suggests that a large amount of interruptions limits the ability for the individual to establish a continuous relationship with their task (Mullarkey et al., 1997), thereby slowing a priori expectations of making progress towards individual goals, which produces feelings of stress (Carver et al., 1990). ICT-enabled interruptions possess several distinct characteristics related to the lack of social presence that leads to an increased number of interruptions. Therefore, because social presence is relatively absent from ICT-enabled interruptions, the increased number of interruptions associated with ICT-enabled quantitative demand can lead stress.

We argue that perceptions of overload arise from quantitative demand when interruption-based demand is in high quantity. Quantitative demand is then a positive correlate to stress. This suggests that a high amount of interruptions serves as a stressor to increase the perception of overload. Hence, we posit the following relationship:

Hypothesis 1: Quantitative Demand associated with ICT – enabled interruptions positively affects Perceptual Overload.

3.4.1.2. Demand Variability

Demand variability affects stress in two ways, by creating overload and ambiguity in the processing of demand (interruption ambiguity). Demand variability refers to the extent that the level of ICT-enabled interruptions remains constant rather than changing from low to high levels (Beehr et al., 2000; Ganster et al., 1986). Demand variability suggests that change in the pacing of interruptions enabled by ICTs may result in employees constantly shifting between underload and overload (Edwards, 1996). Because the workload is not at a steady pace, individuals experience negative reactions from both having underloaded and overloaded demand *in a single episode* – where underload causes stress because it limits the individual's ability to use their skills to the full potential and overload causes stress because the individual has too many requirements given the time (Fineman & Payne, 1981). This suggests that during an episode, when ICT-enabled interruptions are variable, individuals experience both underload and overload, which given the same level of ICT-enabled interruptions would be more stressful than having a steady pace of ICT-enabled interruptions. Overall, frequent feelings of stress can arise when individuals are forced to shift from less ICT-enabled interruptions to a high amount of ICT-enabled interruptions during a single event.

Individuals feel ambiguity when expectations of workload are unclear (Kahn, 1964). In the context of interruptions, when interruptions enabled by ICTs are discontinuous in timing, individuals are experiencing a variable change in the pace of their demand. This causes interruption ambiguity to arise, which occurs when individuals are uncertain about knowing exactly what to expect or how to process the interruption (Fineman et al., 1981). This suggests that employees who consistently shift between having too much or too little to do will manifest stress because it creates ambiguity about the pace of their work (Collie, 2005). For example, when someone is working diligently on preparing a document, having their attention interrupted sporadically through ICTs makes it more difficult to comprehend and adjust to as opposed to a series of ICT-enabled interruptions that are evenly received. Therefore, when an individual can experience a continuous stream of ICT-enabled interruptions, they are more likely to be able to plan and adjust for their arrival, allowing them to more effectively manage their workload.

We posit that demand variability with the ICT-enabled interruptions leads to perceptions of stress because it creates sporadic overload and interruption ambiguity. In this sense, a steady stream of interruptions is associated with less stress than a fluctuating stream. Hence, we posit the following relationships:

> *Hypothesis 2a: Demand Variability associated with ICT – enabled interruptions positively affects Perceptual Overload.*
> *Hypothesis 2b: Demand Variability associated with ICT – enabled interruptions positively affects Perceptual Interruption Ambiguity.*

3.4.1.3. Message Profile

Message profile refers to the source and type of the instrumental pressure tied to each ICT-enabled interruption. This profile is independent of the ICTs because it describes the content within interruptions. In this sense, it relates specifically to the nature of each stressful transaction occurring within the episode. We argue that each ICT-enabled interruption is associated with demand, because when received it automatically pulls attention away from completing a primary task, whether on-task or off-task. However, it is important to note that this hindrance occurs at different levels. Unsupportive interruptions are not related to the current task, while supportive interruptions provide tangible aid in completing the current task. Unsupportive interruptions are more intrusive and disruptive than supportive interruptions (Smith-Lovin et al., 1989) because they completely reallocate attention while supportive interruptions only mildly detract attention. In this sense, when an individual receives messages of support, the supportive nature of ICT-enabled interruptions has fewer negative episodic effects on stress as compared to generally receiving unsupportive messages. Therefore, the type of support associated with ICT-enabled interruptions affects the individual at the episodic level.

Messages can be profiled using two dimensions of support: instrumental support (i.e., type of message: on-task vs. off task) and the source of the support (i.e., source of message: supervisor vs. peer) (Beehr et al., 2000; Carlson et al., 1999). A construct is multidimensional when it consists of a number of interrelated attributes or dimensions (Law, Wong, & Mobley, 1998). Profiles are multidimensional constructs in which its dimensions pair together (Law et al., 1998). In the profile for message, instrumental support and source of support form a multidimensional construct, which cluster together to form a profile. Through its pairing, this profile captures the level of importance, which is derived from the source and type of the interruption (Parkes, 1986).

Instrumental support is characterized by rendering assistance, and is administered through communication, such as aid in the form of advice or knowledge needed to complete a task (Beehr et al., 2000). In our study, we focus on instrumental support as the degree of relatedness between the interruption and the primary task i.e., on-task vs. off-task. An instrumentally supportive interruption is not in conflict with the primary task, but instead adds information to aid in the completion of the primary task. In terms of attention theory, the on-task nature of highly supportive interruptions suggests that when two tasks are related they pull from the same cognitive work sphere, thus lightening the cognitive load the individual is using to complete the task (Meyer et al., 1997). By having to work through less cognitive baggage, the individual is less stressed than if their mind was on overloaded by different types of information. Therefore, because off-task messages impose greater demands on individual's cognitive load as compared to on-task messages, we argue that instrumental pressures arise from off-task messages because they create conflicting demand with the current task.

The source of the stressor suggests that the transaction is interpersonal in nature (Carlson et al., 1999). The source of a message refers to the established relationship that coincides with the interruption message. A variety of sources of ICT-enabled interruptions may prove equally or more intrusive than interruptions high on social presence. In face-to-face contexts, people can only intrude when they are in physical proximity to the individual. However, when using e-mail or instant messenger, one may have people from different parts of their life intrude without being related to the situation. ICTs enable these interruptions more frequently, which evoke stress in the individual.

In an organization, different sources can provide more aid in reducing ambiguity surrounding an event, specifically the supervisor can be more helpful that a peer interaction. While peers may provide support, because the supervisor is in charge of the individual's work goals, their message has an automatic level of priority attached to it, thus reducing uncertainty. For example, when a supervisor (i.e., who in charge of their employees' task requirements) interrupts an individual, regardless of the actual message content, the individual does not feel ambiguity and conflict surrounding the interruption. This is because the difference in power automatically deems the current interruption more important than the task. By sending an interruption to the employee, the supervisor requires that the interruption take priority over the current task. With peers, while the message may be related to the primary task, it may not be agreeable with what the supervisor would suggest as "on-task", thereby making the goals of the primary task more difficult to attain. With limited uncertainty involved in deciding whether the individual should halt the primary task and read and agree with the supervisors message, there is less likelihood of negative effects. Following this logic, since the interruption is automatically prioritized, it is no longer in conflict with the current task, but instead evokes lower demand than a confounding message.

Instrumental and source support are facets of a profile i.e., either the supervisor or the peer is providing tangible support (see Table 3.3) (Kaufmann et al., 1986). In this dissertation, we examine the off-task and on-task messages, while controlling for source. We argue that low instrumental off-task messages give rise to feelings of conflict and ambiguity surrounding an individual's demands. These messages leave the individual uncertain about their behaviors. High instrumental on-task messages are helpful in lightening up the stressful work atmosphere. Therefore, these messages are helpful in reducing perceptions of stress by minimizing conflict and ambiguity. Once in combination with source, these profiles may administer different effects, but it is uncertain what those effects may be. Therefore, studying all four of these profiles is outside the scope of this dissertation.

Table 3-3 Message Profile

		Peer	Supervisor
Instrumental Support	Low Off-Task	Off-task messages from a peer are in conflict with the primary task and create ambiguity about the priority of execution attached to the current demands.	??
	High On-Task	??	On-task messages from a supervisor minimize feelings of conflict and lessen ambiguity about the priority of execution attached to the current demands.

In this study, we examine instrumental support (on-task vs. off task messages) while controlling for source.

Exposure to unsupportive message may strain an individual through increased stress, whereas exposure to episodic stress in the context of a socially supportive environment may lead to positive outcomes. Therefore, we posit that the on-task/off-task nature of the message affects perceptions of stress by creating message ambiguity and conflict. Based on the arguments above, we hypothesize the following relationships:

Hypothesis 3a: Message Profile affects Perceptual Message Ambiguity.
Hypothesis 3b: Message Profile messages affect Perceptual Conflict.

3.4.2. Perceptual Stress

Stress results from the perceived demands within a situation and the person's resources for meeting those demands. Perceptual stress refers to the characteristics of an episode in which the individual perceives adverse consequences from the ICT-enabled interruptions or the messages. This suggests that perceptual stress is formed from a combination of characteristics that occur at the episodic level. These perceptions occur during the primary appraisal stage. As in role stress, episodic overload, ambiguity, and conflict are situational in nature and act as dimensions to form the measure of stress (Carlson, 1999; Peterson et al., 1995; Pierce et al., 1993). The influence each dimension has on strain varies because the dimensions do not correlate (Nygaard et al., 2002). Based on stress's multidimensional nature, we disaggregate each dimension to discuss their independent relationships with strain.

Individuals experience episodic overload when the requirements of the task are too high and there are too many demands for the individual to fill (Tarafdar et al., 2007). For example, in a manufacturing context, Dewyer and Ganster (1991) defined perceptual overload as the perceptual amount of workload i.e., "how often does your job require you to work very fast, how often is there a great deal to be done, etc." They found that overload was associated with negative outcomes, such as tardiness and absenteeism. Our study posits that the perception of overload is directly correlated with strain. Therefore, while tardiness and absenteeism may serve as chronic outcomes that eventually occur from an individual's consistent feelings of overload, we argue that strain is an episodic outcome that results from perceiving too many ICT-enabled interruptions given time period.

Ambiguity refers to the uncertainty about knowing exactly what behavior is expected in one's job (Bedeian & Armenakis, 1981; Kahn, 1964). In an ICT-enabled interruption context, ambiguity can arise from two points: from either the interruption itself, or the message internal to the interruption. Individuals experience interruption ambiguity when they feel uncertain about the ICT-enabled interruptions (Meyer et al., 1997), whether checking the interruptions or performing the task. Interruption ambiguity is similar to priority ambiguity i.e., what order should things should be done (Bauer & Simmons, 2000). Individuals experience ambiguity with the message when the goals of the message are not clear. Moreover, individuals feel uncertain about the message content within the interruptions. This is similar to goal/expectation ambiguity examined in non-ICT based contexts i.e., what should be done? (Sawyer, 1992). Overall, when interruptions and/or messages are ambiguous, we posit that individuals experience more strain.

Episodic conflict occurs when individuals perceive an incompatibility in the demand requirements, where the content of the message conflicts with task. Specifically, when the messages conflict with the duties of the task; individuals experience intersender role conflict because two or more people are communicating expectations that are incompatible (Cooper et al., 2001; Shirom, 1982). For example, conflict occurs when the source and type of the profiled message (i.e., off-task message from a peer) differs from the source and type of the task (i.e., task from the supervisor). Overall, when demands are in conflict with each other, we posit that individuals experience more strain.

The stress to strain relationship is a well documented part of the transactional stress process (Cooper, 1998; French et al., 1982). Therefore, although the link from perceptual stress to objective strain is not the main thrust of this study, it is measured to gain a holistic view of the stressor-stress-strain process. Hence, based on the arguments above, we posit the following relationships:

Hypothesis 4a: Perceptual Overload positively affects Strain.
Hypothesis 4b: Perceptual Interruption Ambiguity positively affects Strain.
Hypothesis 4c: Perceptual Message Ambiguity positively affects Strain.
Hypothesis 4d: Perceptual Conflict positively affects Strain.

3.4.3. Solutions to Stress

Depending on the way work is structured around the technologies, technologies can enable varying objective levels of control (Wall et al., 1990). Some applications have led to advanced control i.e., letting the individual choose when or how to work, while others remove the degree of control from the individual i.e., the technology is set to intrude upon the individual (Wall et al., 1995). In Chapter 2, we found that behavioral control best explained our model of transactional stress and that timing control, method control, and resource control were all forms of behavioral control. We limit our study to these three forms of behavioral control because they shed light into three distinct areas of our model: 1) at the onset of the stressors 2) as ICT-enabled coping behavior and 3) as a non-ICT enabled coping behavior. Therefore, we focus on two elements of control derived from ICT characteristics, timing control and method control, and one general characteristic, resource control, which we will operationalize as the ability to avoid the stressful environment and engage in off-task behavior. These three characteristics interact with demands to manifest responses during an episode.

3.4.3.1. Timing Control

Timing control can overcome stress from demand stressors. Timing control refers to whether the individual can decide *when* they want to be interrupted, rather than responding to intruding messages from ICTs (Van Yperen et al., 2003). If an individual demonstrates control over an interruption, they prepare and exhibit timing control over their behavior. This suggests that if an individual can predict or schedule the interruption through the technology, they are better able to have control over their behavior. This in turn minimizes perceptions of stress. For example, blackberries allow the individual to be continually connected to work, even during off hours. When the blackberry is in its active state, its design prevents the individual from knowing when a new message is going to occur. Instead, interruptions derived from “always-on” technologies have innate properties that make them more intrusive and limit the degree of control the individual can attain over their time and behavior (Tarafdar et al., 2007). Therefore, timing control allows individuals to adjust to demand by letting them control how they receive the interruptions through the technology, thus changing the nature of the interruption from intrusive to passive.

We argue that timing control over the ICT will negatively moderate the relationship between ICT-enabled demands and episodic stress. This suggests that raising the level of timing control will minimize the negative effects from *ICT-enabled* interruptions on perceptual stress. This includes the relationship quantitative demand has with overload i.e., (h1a) and the relationships demand variability has with overload and ambiguity i.e., (h2a, h2b). Therefore, timing control minimizes the effects from having both a high number of interruptions and an inconsistent flow of interruptions.

We hypothesized that quantitative demand effects perceptual overload at the episodic level. When individuals have timing control, they are better equipped to distribute their attention efficiently even when needing to process a high number of interruptions within the technology. This is because timing control lets individuals organize their time their way. For example, if an individual has 10 messages, timing control would force the messages to collect passively within an ICT until the individual consciously chooses to view them. We posit that control over the timing of interruptions through the ICT can enable individuals to view the messages at less points in time, while is less stressful then switching their attention each time a message occurs during a task. This is because it takes less cognition to switch one time versus switching 10 times.

We hypothesized that demand variability effects perceptual overload and interruption ambiguity at the episodic level. Through timing control, individual's have more certainty in knowing when they are to stop their flow of concentration with the primary task. By increasing the certainty, ICT-enabled timing control is offsetting the relationship between demand variability and ambiguity. Similarly, because the individual is in charge of the timing of messages, they can limit the feelings of sporadic overload that demand variability creates with having no timing control enabled by the ICT.

Since timing control moderates the relationships between ICT-enabled demands and stress, it only interacts with the three proposed relationships. Moreover, timing control has no effect on conflict, which is associated with the message profile. Based on this reasoning, we propose that raising the level of timing control mitigates the effects of ICT-enabled demand on individuals' perceptions of stress. Hence, we posit the following relationships:

Hypothesis 5a: Timing Control over the ICT negatively moderates the relationship between Quantitative Demand and Perceptual Overload.

Hypothesis 5b: Timing Control over the ICT negatively moderates the relationship between Demand Variability and Perceptual Overload.

Hypothesis 5c: Timing Control over the ICT negatively moderates the relationship between Demand Variability and Perceptual Interruption Ambiguity.

3.4.4. Solutions to Strain

The transactional model argued that control would be needed as the result of both primary and secondary appraisals. Timing control occurs at the onset of the stressors and therefore helps determine the primary appraisal. Method control and resource control result from the secondary appraisal, and therefore are coping behaviors.

When an environment is stressful to an individual, the individual will make a secondary appraisal to evaluate options in the environment and any alternate coping behaviors that will lessen the physiological impact on the body. At this point, it does not matter what dimensions of stress were rated high during the primary appraisal (i.e., overload, conflict, message ambiguity, or interruption ambiguity) because a new appraisal of the environment takes place which leads to specific coping behaviors that have the sole purpose of offsetting strain. Therefore, if the secondary appraisal suggests a change is desirable, one engages in coping behaviors, and these coping behaviors change the environment lessoning the impact on strain. Hence, we posit the following relationship:

> *Hypothesis 6: Coping negatively moderates the relationship between Perceptual Stress and Strain.*

3.4.4.1. Method Control

Method control is an ICT-enabled coping technique that is used in situations where individuals believe they have control over the ICT-enabled environment. Since technologies have different design elements, when ICTs limit *how* individuals accomplish tasks, coping behaviors cannot be perceived during the secondary appraisal, and method control cannot be enacted when stress is high. However, through coping, method control can alter the current feelings about stress, and thus lessen the impact on strain. Specifically, method control focuses on enacting the option to control how to carry out the technology –based work associated with completing the primary task (Wall et al., 1990). No method control suggests that individuals do not cope with their level of stress by changing how they accomplish the task. Therefore, if the option to use method control is not enacted, the individual will not reap the benefits of this coping option.

We argued above that demand variability creates feelings of ambiguity with the current job task. In order to account for ambiguous demand, method control suggests that certain ICTs can enable individual to choose *how* to readjust their behaviors with the ICT-enabled task. For example, an individual working diligently on a document that is receiving a high demand of interruptions can choose to search for additional information on how to fulfill the document requirements, thus coping with the initial level of ambiguity. This suggests that if ambiguity is present from the ICT enabled interruptions, but the individual does not enact coping behaviors through method control over the ICT to help offset that ambiguity, the individual will be strained. On the opposite hand, when users can enact control over how they handle the ambiguous demand from the ICT, they are less likely to be strained.

Quantitative demand creates feelings of overload from the ICT-enabled interruptions. These feelings of overload can be lessened by allowing individuals to enact control over *how* they accomplish their task. For example, if individuals are given a task with instructions to write an essay, if no method control is available, they cannot improve upon how they accomplish the task i.e., they must use only one means (their own knowledge stock) to write an essay. However, if method control is available with the primary task and the individual needs to cope with the current feelings of overload created from ICT-enabled interruptions, then they will enact the option and change their method of working i.e., using online sources to build their arguments in the essay. Therefore, when individuals feel overloaded, coping through method control can help lighten their cognitive burden that occurs from a demanding environment, and thus lessen the relationship between perceptual stress and strain.

We argue that raising the level of method control associated with the ICT mitigates the negative effects of perceptions of overload and ambiguity on strain. Thus, regardless of the type of stress created directly from ICT-enabled interruptions (including overload and ambiguity), adding method control improves an individual's odds to accomplish the primary task, which lessons the strain. Hence, we posit the following relationship:

> *Hypothesis 6a: Method Control over the ICT negatively moderates the relationship between* Perceptual *Stress and Strain.*

3.4.4.2. Resource Control

Resource control refers to enacting the option to relax from the ICT environment and engage in off-task behavior. Resource control is independent of the ICTs, but describes the behaviors associated with escaping from the ICT environment. Like method control, resource control is also a function of the secondary appraisal, and therefore a coping behavior. This suggests that an individual cannot enact resource control until after the individual feels stress and evaluates the options in the environment in a secondary appraisal. However, like method control, if the option is not enacted, the individual will not reap the benefits of this coping option. Resource control avoids focusing on the stressors for a brief period of time. Specifically, to account for the stress at a high demand, individuals *enact* their option to take a break from the ICT environment in order to evade from workplace stressors.

It has been suggested that it is advantageous for individuals to use active coping methods that remove the stressor from the individual's environment or attenuate its effects (Carver et al., 1989; Jex, Bliese, Buzzell, & Primeau, 2001). For example, Karasek, Russell and Theorell (1982) point to evidence for lower heart rate and blood pressure that may have occurred as a side effect from the utilization of short self-paced relaxation periods(Landsbergis, 1988). Others have also acknowledged that resting periods, or periods when the individual can relax their mind, reduces the amount of strain (Brillhart, 2004). Relaxation has even been shown to be an alternative medicine to stress outcomes, like the irritable bowel syndrome (Yuan et al., 2003). When individuals use resource control, they are taking advantage of clearing out their cognitive and emotional baggage associated with feelings of overload, conflict, or ambiguity. This can allow them to mitigate the effects of stress and focus their thoughts on how to complete the primary task. Because this coping behavior helps distress, it offsets the effects overload, ambiguity, and conflict have on strain. Therefore, resource control lessens the negative effects of perceptions on strain, thus suggesting a moderating relationship with the perceptions of stress.

Based on the arguments above, we posit that resource control serves as an active coping mechanism to decrease overall strain. If an individual is overloaded or filled with ambiguity due to high demand or conflicted due to confounding messages, providing resource control actively allows the individual to cope with actions that aid in completing the primary task and reduce overall levels of strain. Therefore, coping behavior is not needed when feelings of stress are low. Hence, we posit the following relationship:

Hypothesis 6b: Resource control associated with escaping from the ICT environment negatively moderates the relationship between Perceptual *Stress and Strain.*

Table 3-4 summarizes the hypotheses.

Table 3-4 Summary of Hypotheses	
Hypothesis 1	Quantitative demand associated with ICT – enabled interruptions positively affects perceptual overload.
Hypothesis 2a	Demand variability associated with ICT – enabled interruptions positively affects perceptual overload.
Hypothesis 2b	Demand variability associated with ICT – enabled interruptions positively affects perceptual interruption ambiguity.
Hypothesis 3a	Message profile affects perceptual message ambiguity.
Hypothesis 3b	Message profile affects perceptual conflict.
Hypothesis 4a	Perceptual overload positively affects strain.
Hypothesis 4b	Perceptual interruption ambiguity positively affects strain.
Hypothesis 4c	Perceptual message ambiguity positively affects strain.
Hypothesis 4d	Perceptual conflict positively affects strain.
Hypothesis 5a	Timing control over the ICT negatively moderates the relationship between quantitative demand and perceptual overload.
Hypothesis 5b	Timing control over the ICT negatively moderates the relationship between demand variability and perceptual overload.
Hypothesis 5c	Timing control over the ICT negatively moderates the relationship between demand variability and perceptual interruption ambiguity.
Hypothesis 6	Coping negatively moderates the relationship between perceptual stress and strain.
Hypothesis 6a	Method control over the ICT negatively moderates the relationship between perceptual stress and strain.
Hypothesis 6b	Resource control associated with escaping from the ICT environment negatively moderates the relationship between perceptual stress and strain.

3.5. Conclusion

In this chapter, we identified several pressures surrounding ICT-enabled demand (quantitative demand and demand variability) due to interruptions and message characteristics within interruptions (message profile). We also identified several solutions regarding ICT-enabled control and coping behaviors: timing control, method control and resource control. Applying these factors within the demands control model, we argued that control factors mitigate the effects of high demand on both perceptual stress and strain. Based on our findings, a research model was developed and hypotheses were theorized.

The next chapter proposes the research methodology used to test the above hypotheses.

Chapter 4. Research Method

4.1. Introduction

In the last chapter, we introduced a research model that examines the interactions of ICT-enabled interruptions (quantitative demand and demand variability) and support characteristics within interruptions (message profile) with ICT-enabled control (timing control) and coping behaviors (method control and resource control). We argued that control factors mitigate the effects of high demand on perceptual stress and strain.

In this chapter, we describe the method used to test the hypotheses in our research model. We begin by discussing research design and explain why an experiment is the appropriate method to test our research model. Next, we formally discuss the foundation of the study. Then, we set up two laboratory experiments used to test the model. Here, we provide details on the measures used to evaluate stress and map out the experimental design for each experiment. Finally, we provide details on the control variables used in the study. We conclude by describing the stages of analysis that will be used to evaluate our hypotheses. Figure 4-1 describes the organization of this chapter.

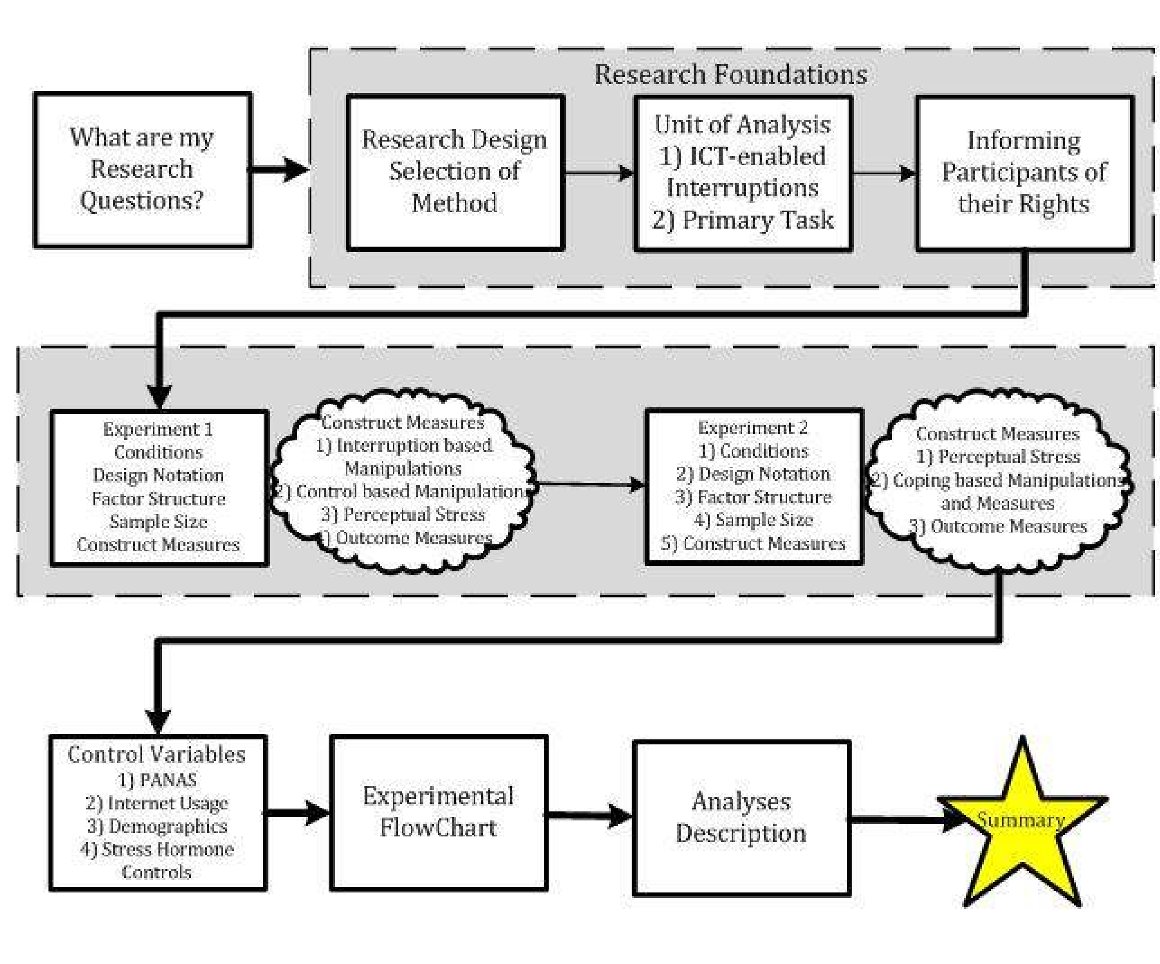


Figure 4-1 Organization of Methods Chapter

4.2. Research Foundations

In this section, we lay the foundation for the laboratory experiments we use to test the hypotheses in our research model. Even though we test our model in two separate laboratory experiments, the foundation is the same for both studies (i.e., the design, the unit of analysis, etc.). Therefore, we begin by explaining why an experiment is the appropriate method to test our research model. Next, we formally discuss the operationalization of the study's level of analysis (i.e., the episode). Then, we discuss how this research is compliant with the institutional review board, how we informed participants of their rights, and what incentives were used to motivate our participants.

4.2.1 Research Design

When selecting a research design, it is important to select a technique that best supports the research questions. In Chapter 1, we defined our research questions as the following: *Do ICT-enabled forms of interruptions create demands that induce stress?* and *If so, do ICT-enabled forms of control mitigate the effects of technology-enabled interruptions on episodic stress?*

Causality predicts the relationship between two events such that something happens that in turn causes something else to happen (Spirtes, Glymour, & Scheines, 2000). Experiments use a longitudinal design to allow the investigator to have better control over the explicit timing of a specific process. Experiments are a useful method in examining causality because they allow the researchers to capture processes while also eliminating extraneous factors that may occur in real-life settings (Gefen & Ridings, 2002). In this sense, by manipulating factors and measuring their effects, we can determine the direction of causality (Trochim, 2004). Therefore, we use an experiment in this study because we are interested in explaining variance and establishing causal relationships.

Based on the above reasoning, we adopt an experimental design to test our research model, which accounts for episodic factors that induce stress in individuals and helps to elucidate the processes related to episodic stress. The next section discusses the operationalization of the unit of analysis in this study, which is followed by a detailed discussion of our broad experimental design.

4.2.2 Unit of Analysis

Our objective is to examine the transactional stress process in an ICT-enabled interruption context occurring at the episodic level. In this study, the episode includes two components: 1) ICT-enabled interruptions and 2) a primary task (see Table 4-1). To operationalize an episode, we argue that a person has a set amount of time to complete the specific task while receiving demands from varying forms of ICT-enabled interruptions. Therefore, the episode begins at the start of the primary task during which participants receive a series of ICT-enabled interruptions. The episode ends twenty minutes after the start of the primary task. At the end of the episode, the task should be complete, the interruptions have finished intruding, a degree of stress should be felt, and strain should be apparent.

Table 4-1 Levels of Analysis

Level of Stressors/Strain	Conceptual Definition	Operational Level of Study	Time Duration
Episode	A sudden momentous negative event that occurs when stressors appear from time to time but are not ongoing.	A set duration of time when the subject receives the stressors while working on a primary task to the time when the task is finished, strain is manifested, and outcomes are measurable.	20 minutes Estimated time to complete a standardized essay.

In the episode, the primary task is held constant while we manipulate various characteristics of the ICT-enabled interruptions. The primary task was formally defined after rigorous testing. First, the PI put together a *think tank* with 20 undergraduate students. Think tanks have been around since the 1940s and are now often applied to groups chosen to solve a problem[1]. During the think tank, the members were given an assignment to find a task that 1) they found to be engaging and2) took about 20 minutes. They were instructed to write down all of the steps that they had to take to complete in this task (i.e., *Is your task a series of mini-tasks or one big task?*) In addition, they were encouraged to get together and discuss their ideas.

The rationale for the think tank was to find a task that had no qualitative limitations for undergraduate students and, therefore, would not be a source of stress for them. Instead, the task needed to be engaging, which differs from a stressful task. An engaging task lets subjects establish a continuous relationship and become absorbed into their workload (Tellegen & Atkingon, 1974). In this sense, while the primary task does serve as demand, it does *not* serve as a stressor. In our experiments, the ICT-enabled interruptions are the only stressors manipulated for demand, while varying levels of control serves as solutions to those demands; therefore, the task needed to be something that everyone had knowledge to do without needing extra directions.

Based on this rationale, many ideas were discarded, as not all 20 students were comfortable with completing them. For example, all business students are required to take a decision-modeling course. Generally, making a simple model takes about 20 minutes and requires little outside resources. However, the sheer instructions of a model could potentially create additional stress on many students outside of the business field.

---

[1] See http://www.businessdictionary.com/definition/think-tank.html

The think tank provided other ideas as well, such as online car buying and real estate investing. However, these tasks require a large amount of Internet resources and are difficult to control in an experimental setting. After pretesting the various tasks, we determined that the most efficient task was a standardized essay, which almost every undergraduate student has the fundamental knowledge to create. Two examples of tasks and instructions (both for controlled and uncontrolled environments) are located in Appendix 1.

The participants were instructed to answer the essay question using Microsoft Word. Specifically, they were given 20 minutes to write a short essay, which were adapted from practice essays for the Graduate Management Admission (GMAT) test. While the GMAT typically allocates a maximum of 30 minutes to write and prepare an analogous essay, to ensure the subjects did not finish at different rates and become bored, this time was shortened by 10 minutes. This time difference was calibrated during the pretest and was revalidated during the pilot study. This way, the subjects stayed *engaged* in the task even if they did not finish it on time, thus compelling the level of urgency to stay high.

Consistent with the GMAT, the instructions requested that the essay must be comprised of greater than 325 words, consist of an introductory paragraph, a body of one or more paragraphs, and a closing paragraph. Subjects were also instructed to use reasons and/or examples from their experiences, observations, Internet usage (depending on their experimental grouping), and/or readings to explain their viewpoint. Finally, they were informed that the grading scale would focus on the *number of words*, the *clarity of their writing*, and their *critical* and *reasoning skills*. This grading scale helped calibrate the level of incentives they received, which is discussed in Section 4.2.3.3.

4.2.3 Research Compliance

4.2.3.1. Sample Frame

In order to understand the compliance of this study with the institutional review board's requirements, we set the boundary conditions for selecting subjects by naming our sample frame. While we are concerned with a workplace environment, for our experimental design, the sample frame does not have to be highly restrictive, as is the case for a survey, in which organizational workers would be the clear sample frame. Instead, because interruptions are characteristic of nearly every individual who does IT-enabled work, students were a valid sample. However, because our experiment centers on stress, we also considered the health effects on our participants. Therefore, we used a stratified random sample that met two qualifications, which are summarized in Table 4-2.

The first qualification of our sample focused on individuals who use ICTs regularly at work or at home. At the southeastern college at which this study occurred, undergraduate students are required to carry a laptop and frequently use IT to help them accomplish their class-related tasks. Within this sample, we randomized the design so that they shared a certain probability of having a characteristic occur. By selecting a random sample, we were able to compute a sampling error to control for unwarranted results, which helped this work's reliability. The undergraduate student group met the initial qualifications but was still a broad enough sample to be recruited randomly to participate.

The second qualification of our sample related to subjects who had no known heart conditions, increased blood pressure, or diagnosed elevated stress levels. Even though subjects were recruited randomly, because our measures specifically capture stress from bodily fluids, we could not allow subjects to participate if they had any of the aforementioned conditions. Therefore, when selecting our sample, if these issues became apparent during the experiment, we had to terminate that person'sparticipation to protect the subject and to limit biased results in the measurement of strain. Undergraduate students at this campus are typically recruited straight out of high school; thus, because of their young age, they were less likely to have developed the issues stated above.

Table 4-2 Sample Frame Qualifications

1.	Individuals who use IT moderately to regularly.
2.	Individuals with no known heart conditions, increased blood pressure, or diagnosed elevated stress levels.

4.2.3.2. Participants Rights

After reviewing the document *Guidance on the Use of Students as Research Participants*, we carefully assessed how we would protect our subjects from feeling any sort of pressure to participate in this research. Students were recruited by verbal announcements in undergraduate classes and by email. The PI entered each class and provided them with the opportunity to participateand discussed the incentives for doing so. If students wanted to participate from her courses, the data was collected by another member of the research team. Subject solicitation was done in a non-coercive manner, and students were given a contact information for a third party if they felt coercion at any time. Students were provided with this information in addition to being provided with standard information and consent forms. The PI was not required to gain access to people or data that is not publicly available.

Prior to participating, subjects were informed that their responses would contribute to a comprehensive understanding of employee needs and concerns regarding workplace stress and supportive activities. They were also informed of two risks: 1) since the study is designed to create stress, they may feel temporary discomfort from a higher stress level and 2) since the measures capture saliva, they were informed about the salivette administration and the discomfort they may feel during collection times. Overall, the discomfort of this study was designed to be comparable to the discomfort an individual may feel in an everyday worklife environment. Finally, it was stressed to the subjects that the participation was voluntary and that they may choose not to participate and withdraw their consent at any time.

4.2.3.3. Participants Incentives

When informing participants of their rights as subjects, we stressed the urgency in completing the primary task and performing it well by describing the incentives associated with the task. We provided incentives to participants in three ways. First, when subjects performed *exceptionally*, equal to a six on a standardized test, they received an ten dollars and were entered into a raffle for an iPod touch two times. If they performed *very satisfactorily*, they received eight dollars and were entered into a raffle for an iPod touch one time. If their level of performance was *satisfactory*, they received seven dollars. *Below average* and *well below average* equated to six and five dollars, respectively. Since no more than 200 people were to participate in all, the high probability involved in winning the iPod touch helped to increase the urgency associated with performing well.

4.2.3.4. The Institutional Review Board

After two revisions under a full review with the Institutional Review Board (IRB), we were instructed to resubmit the experiment as an expedited review. An expedited review suggests that our research involved no more than "minimal risk" to the subjects and fell within defined expedited categories as approved by the stated university. In spring 2009 the original informational letter was amended to fit the adjustments we believed needed to be changed as a result of the pilot test. Amended requests must go back under review for approval. The final approved informational letter from the IRB is located in Appendix 4[2].

The review board was instructed that there would be a master list of respondents and that the subjects' information was not recorded in any way that harm or criminal activity could come to them. The proctor separated the subject's names from their answers, and they were strictly used to verify that the subjects only participated in the experiment once, that they were affiliated with the stated university, and that they

---

[2] Federal regulations require that the signed Informed Consent Forms be maintained for a minimum of three years following completion of the research \study.

received compensation. The students were assigned a number (also known as their SIMID) that was part of a strict coding system. This SIMID was attached to each measure and response. Finally, subjects were made aware that no one besides the main researcher would have access to the names and answers and that all of the papers that identified the subjects would be kept in a locked filing cabinet.

4.2.3.5. Training

While ensuring participants, rights, the PI underwent several training sessions to ensure correct usage and handling of the objective measures. During these sessions, the PI learned 1) the appropriate way to handle participants when taking their heart rate and blood pressure readings, 2) to approximate the appropriate timeline of salivary increases, and 3) how to handle and transport hazardous materials. First, the PI underwent 25 hours of training on using objective measures in a non-invasive way. This included careful placement of the blood pressure cuff on the body, with the cuffed forearm parallel to the floor, the proper way to identify and remove inappropriate subjects (i.e., subjects that were not healthy enough to be stressed), how to make subjects feel comfortable while administering testing, and how to limit their movement during the experiment. Second, the PI submitted her experimental design to Salimetrics. Because they had a vested interest in having the experiment succeed, they provided some insight into approximating the cortisol and alpha-amylase increases and stabilization. During this time, the PI interviewed a key informant at Salimetrics to go over the timing of sample collection and potential contamination issues that needed to be acknowledged and addressed in the study (Granger et al., 2007). Finally, because the objective measures required saliva collection, the PI underwent training and received certification for collecting, handling, and shipping hazardous materials (HAZMAT). At our university, one obtains this certification through the recommendation of the IRB and by passing a comprehensive class, HM181. Overall, these training sessions helped ensure the validity of the PI's study prior to execution.

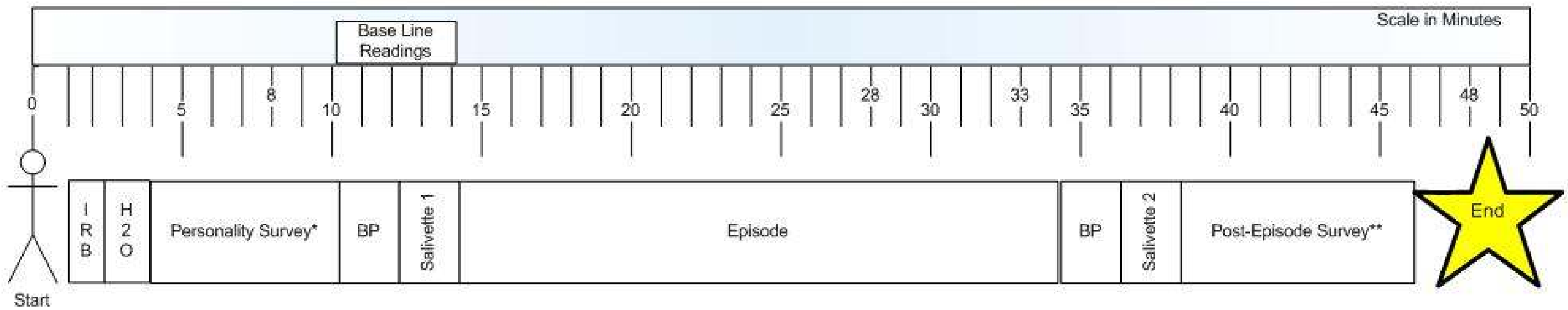
4.2.4 Experimental Flow Chart

Figure 4-2 depicts the final flow chart for the laboratory experiments. Even though the research model was tested using two separate laboratory experiments, each subject was taken though the same process.

Prior to being allowed to begin the experiment, the participants were informed of their rights and agreed to the study by signing the approved IRB letter (See Appendix 4). It is very critical when dealing with stress measures, particularly salivary measures, to have a steady baseline resting rate prior to starting the experiment (Rohleder, Nater, Maldonado, & Kirschbaum, 2006). This was achieved in three ways. First, hormone readings in the morning are generally less stable than those done in the afternoon (Dickerson & Kemeny, 2004); therefore, all experiments were conducted after 11:00 a.m., when hormones are relatively stable. Second, since we were using salivary measures, it was critical to have the subjects wash their mouth out with water 10 minutes prior to collection. This prevents contaminants from entering the salivette. Finally, while people have their own relaxation techniques, the most effective way to relax is to breathe deeply through your nose in a calm environment for 10 minutes. Consequently, before taking the initial readings, subjects were placed in a calm environment in which distractions, such as noise, were limited and the room temperature was appropriate. In this environment, the subjects were asked to take deep breaths to calm themselves. While keeping the calmness of the environment steady, instead of providing complete downtime when subjects' minds could wander, we kept them busy by administering a survey for dispositional and demographic control variables, including Internet usage, gender, and age (see Appendix 3b).

After the 10 minutes, the principle investigator took the first set of readings, including alpha-amylase, blood pressure, and pulse rate. This required two tools: one for salivette and one for blood pressure. The alpha-amylase hormone was extracted from the salivette at the laboratory once the samples were frozen and shipped. Together, the blood pressure machine and the salivette took approximately three minutes to administer.

After the baseline readings were taken, the participants were given a single sheet of instructions for the episode, which they promptly began after it was clear that they understood the task. As discussed above, subjects were given 20 minutes to complete the task. After the episode was complete, we took their blood pressure and pulse rate again. Then, we administered the second salivette. After the objective measures were taken, we administered the second survey for the perpetual demands, control, outcomes, and episodic control variables (i.e., PANAS) (see Appendix 2 and 3a). We concluded the experiment by debriefing the subjects and answering any questions they might have.



* Survey includes items for Internet usage, demographic variables, and stress hormone controls. See Appendix 3b for survey details.

** Survey includes manipulation checks for quantitative demand, demand variability, message profile, timing control, method control, and resource control. It also includes items for overload, ambiguity, conflict, strain, and episodic control variable PANAS. See Appendix 2 and 3a for survey details.

Figure 4-2 Experimental Flowchart

4.3. Experiment 1

4.3.1 Experimental Design

In this section, we define the broad experimental design for this study, including the experimental conditions, design notations, sample-size requirements, and sample selection. The hypothesized relationships were tested through two laboratory experiments. The first study tested the direct effects of the independent variables along with the interacting effects of the timing control (hypotheses 1 through 5). The second study tested coping behaviors by setting all four factors in Experiment 1 at high and allowing subjects to cope or not to cope (hypotheses 6, 6a, and 6b).

Figure 4-3 presents the research model for Experiment 1. In this experiment, we only manipulate the characteristics of ICT-enabled interruptions, while holding the primary task constant.

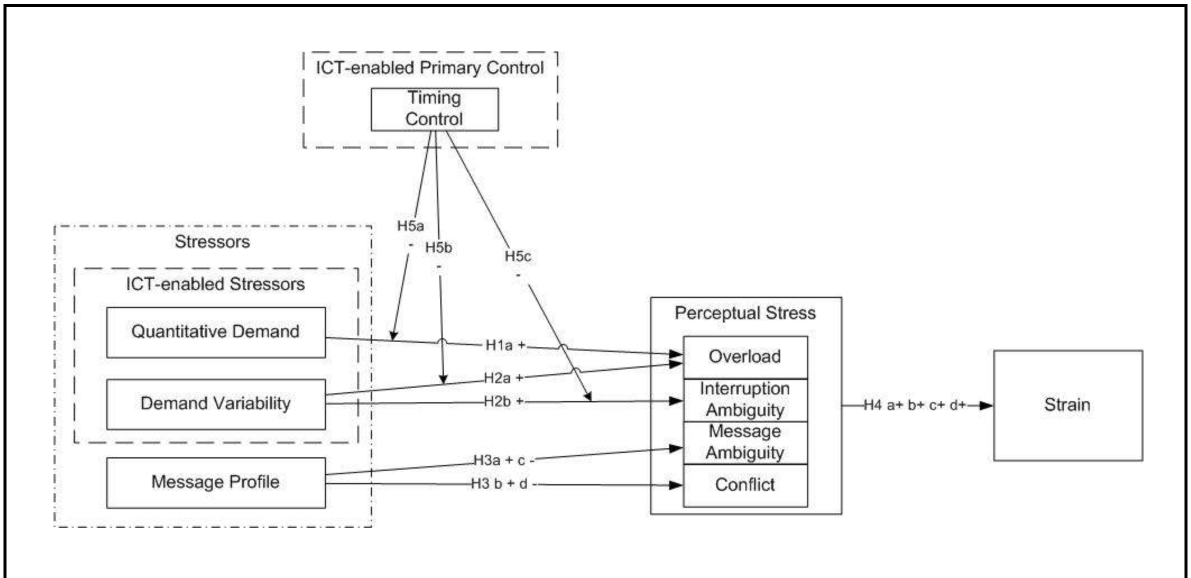


Figure 4-3 Experiment 1: Research Model

In this section, we explain the experimental conditions, the design notation, the factor structure, the sample size, and the measurement of the constructs used in the experiment, including manipulations of the ICT-enabled interruptions and control, perceptual variables, items associated with the perceptual variables, and objective indicators. Independent variables were set up by explaining their objective experimental manipulation and by presenting their associated scales. Then, we set up two sets of outcomes: 1) perceptual stress and 2) objective strain. The perceptual variables were measured using questionnaires, and the outcome variables were measured using objective indicators: alpha-amylase levels, blood pressure, and pulse rate. The objective indicators, the perceptual variables, the objective outcomes, and their associated scales are presented in this section. Appendix 2 presents the formatted survey used in this experiment.

4.3.2 Experimental Conditions

The experimental conditions are the factors that we manipulated in the experiment, which were derived from the objective indicators we discussed in Chapter 3 (i.e., the independent and moderating variables) (see Table 4-3). These conditions, which are discussed below, do not include the dependent variables through which we also gathered the perceptual and objective outcomes.

The first experiment tested the direct effects of the independent variables along with the interacting effect of the timing control (hypotheses 1 through 4). Based on the demands control model, which overarches our model, we had two factors: demands and control. In Experiment 1, three variables made up the demands factor and one variable made up the control factor. Table 4-3 illustrates that all of the factors were examined as across units. These factors are referred to as between-factors. Each condition can be measured at any number of levels, with the most common number being two levels of study (i.e., demand variability low and high).

Table 4-3 Experimental Conditions: Experiment 1

Category	Variable	Experimental Manipulation	Level
Demand Stressor	Quantitative Demand	*Between Factor:*	
		High Number of Interruptions	2
		Moderate Number of Interruptions	1
Demand Stressor	Demand Variability	*Between Factor:*	
		Variable Interruptions	2
		Consistent Interruptions	1
Demand Stressor	Message Profile	*Between Factor:*	
		Confounding – Not supportive	2

		Cooperative – Supportive	1
Primary Control	Timing Control	*Between Factor:*	
		Email Client with Pop Up Functions	2
		Email Client with Control	1

4.3.3. Design Notation

The research design informs us how the factors fit together. Table 4-4 shows the design notation for a before- and after-treatment experimental design. A before and after design suggests that we observe (or measure) our constructs before and after we administer the treatment (Trochim, 2004). There are eight lines in the notation, signaling that there were eight groups in the analysis. The R at the beginning of each line indicates that individuals were randomly assigned. The subscripts alongside the X indicate the combination of treatments each group received. Each subscript represents a treatment, and the four treatments are ordered in the following manner: quantitative demand, demand variability, message profile, and timing control. Therefore, X_{2111} indicates that a group of subjects will receive a high level of quantitative demand and low levels of demand variability, timing control, and conflicting message profile.

The repeated nature of the design allowed each individual to provide more than one observation on the same dependent variable (i.e., stress/strain) by providing a pre-treatment and post-treatment measure across time (i.e., before and after the episode) (O'Brien & Kaiser, 1985). Repeated design experiments are a type of factorial experiment for which the treatment (i.e., the episode) and time (i.e., time 1, time 2) serve as two separate factors that are linked to one common factor—the individual. Therefore, in our study, the difference in readings between the two time periods (time 1 and time 2) will form the measure of the observation.

Table 4-4 Incomplete Block Design Notation: Experiment 1

Group Number	Random Assignment	Observation Pre-Treatment	Treatment	Observation Post-Treatment
		Time →		
1	R[a]	O	X_{1111} [bcd]	O
2	R	O	X_{2111}	O
3	R	O	X_{1211}	O
4	R	O	X_{1121}	O
5	R	O	X_{1112}	O
6	R	O	X_{2112}	O
7	R	O	X_{1212}	O
8	R	O	X_{1122}	O

[a] R1 denotes random assignment
[b] 1 denotes level 1 (low; cooperative)
[c] 2 denotes level 2 (high; conflicting)
[d] Treatment Order: quantitative demand, demand variability, message profile, timing control

4.3.4. Factor Structure

Table 4-5 shows the factor structure of the incomplete block design for Experiment 1. Group 1 was our "low strain" group, which had a low level of quantitative demand, demand variability, message profile, and timing control. We changed group 2 to have a high level of quantitative demand, thus enabling us to test hypothesis 1 (that quantitative demand leads to perceptual overload). Group 3 had a low level of quantitative demand but had a variable level of demand, thus enabling us to test hypotheses 2a and 2b. Group 4 had off task messages, thus enabling us to test hypotheses 3a and 3b. We took away timing control from groups 6 and 7, thus testing the interaction (hypothesis 5a, b, and c).

Group 5 had low demand stressors with no timing control. This was contrasted with the low demand stressors group that did have timing control (group 1). The experiment done with group 8 ensured that message profile did not have an interaction with timing control. This was compared to group 4, which had off-task messages and timing control. Groups 5 and 8 did not have any hypotheses relating to what they were testing but were collected for exploratory research. The incomplete design allowed us to focus our tests on the theorized hypotheses, leaving room to explore two- and three-way interactions in the future. During the experiment, the subjects were randomly placed into a group considering the design until the appropriate sample size was reached. By enforcing a random design, we could assume that everything is equal except those factors that we were directly manipulating (Trochim, 2004).

Table 4-5 Factor Structure Experiment 1

Message Profile							
On-Task							
Timing Control							
Yes				No			
Quantitative Demand	Low	1	3	Quantitative Demand	Low	5	7
	High	2			High	6	
Demand Variability		Low	High	Demand Variability		Low	High
Message Profile							
Off-Task							
Timing Control							
Yes				No			
Quantitative Demand	Low	4		Quantitative Demand	Low	8	
	High				High		
Demand Variability		Low	High	Demand Variability		Low	High

4.3.5. Sample Size

We conducted a power analysis to approximate the needed sample size for Experiment 1. In experimental design, the number of groups from the design notation serves as a basis for the power analysis. This concept enabled us to determine what number of observations would provide us with a sufficient power to detect the appropriate response. Table 4-6 provides output from Gpower software, a program that approximates the sample size of studies based on its type of design and number of groups. Based on the design notation listed above, Experiment 1 tested eight groups, the direct effects of quantitative demand, demand variability, message profile, and the interacting effect of timing control. We determined that a sample size of 64 individuals would be the minimum sample needed to give us an approximate power of .95 (considering a medium effect size and an alpha at .05), which is an exceptional level of power to achieve in experimental design (Cohen, 1992). Since we have eight groups, 64 subjects places eight observations in each cell. Because this was a minimum number for which to aim, we decided to increase our sample size to 10 subjects per cell, or 80 people for Experiment 1.

Table 4-6 G-Power Analysis: Experiment 1

F tests - MANOVA: Global effects			
	A priori: Compute required sample size		
Input	Effect size $f^2(V)$	=	0.25
	α err prob	=	0.05
	Power (1-β err prob)	=	0.95
	Number of groups	=	8
	Response variables	=	2
Output	Noncentrality parameter λ	=	32

	Critical F	=	1.781
	Numerator df	=	14
	Denominator df	=	112
	Total sample size	=	64
	Actual power	=	0.96
MINIMUM sample size needed: 64 ** Gpower estimated a lower sample size for study 1 when the power was set to 0.80, so we increased it to 0.95. Study 2 was kept at .80.			

4.3.6. Construct Measures

4.3.6.1 Interruption-Based Manipulations

Quantitative demand refers to the number of ICT-enabled interruptions that occur during an episode. We argue that ICTs can enable multiple interruptions during an episode. We examined three levels of quantitative demand: moderate demand, high demand, and the exploratory low demand in which boredom and frustration may occur. Objectively, the number of interruptions per category was calibrated during the pretest, which will be discussed in section 4.6.1. We found that one interruption per minute was moderately demanding, one interruption every 20 seconds was highly demanding, and one interruption every five minutes imposed low demands. Table 4-7 presents the manipulation checks that correspond to the individual's perception of the objective level of demand.

Table 4-7 Quantitative Demand
Below are listed a number of statements that are used to describe the demand you received during the task. Please read each statement carefully and indicate the extent to which each is an accurate or an inaccurate description of your amount of workload during the task.
Thinking about the interruptions you received while completing the task, answer the following

questions.
Measured from Strongly Disagree (1) to Strongly Agree (5).
The number of interruptions was challenging.
I received too many interruptions during the task.
I experienced many distractions during the task.
The interruptions came frequently.
How many messages do you think you received—estimated number? [a]
[a] This item was asked at the end of the survey to reduce response bias on the remainder of the items.

Demand variability refers to the extent that the level of ICT-enabled interruptions remains constant rather than changing from low to high levels. In the experiment, demand variability was characterized by the pacing of the ICT-enabled interruptions. Moreover, to measure this construct, we manipulated the specific timing of the incoming interruptions. The interruptions were either presented to the subjects at a designated time interval (i.e., every 24 seconds), or the subjects received and had to interpret the interruptions at random times. This is different from quantitative demand in which the number of interruptions was either high or low. Instead, demand variability takes the quantity of interruptions determined in the quantitative demand condition and schedules their timing, whether they were random or consistent. Table 4-8 presents the manipulation check for demand variability.

Table 4-8 Demand Variability
Below are listed a number of statements that are used to describe the demand you received during the task. Please read each statement carefully and indicate the extent to which each is an accurate or an inaccurate description of your amount of workload during the task.
Thinking about the interruptions you received while completing the task, and answer the following questions.
Measured from Strongly Disagree (1) to Strongly Agree (5).
The interruptions arrived at an even pace.

I received a varying number of interruptions.
I received interruptions sporadically.
The interruptions came inconsistently.

Message profile refers to the source and type of the interpersonal pressure tied to each ICT-enabled interruption. Message profile is quantified by the level of support that aids the participantwhen he/she attempts to accomplish the primary task. Examples of messages appear in Table 4-9

To measure message profile objectively, we manipulated the content of the message. Cooperative messages provided information on the current task and were from someone in charge of the experiment. The proctor was in charge of grading the task and determining the level of incentive; therefore, the proctor in the experimental setting was analogous to a supervisor in an organizational setting. For example, if the task was related to innovation, the message would help promote individual thinking along those lines. In this sense, cooperative messages directly aided the subject in completing the given task.

Confounding messages from a peer with no stake in the task or the incentives were formed to distract the individual from the current task. Confounding messages were designed to be off-task but reflected messages that organizational workers could actually receive in a real work setting. In this sense, the messages were not so far removed from the situation that it would be unlikely to be seen in practice.

Table 4-9 Message Profile Examples

Task	The following appeared as part of an article in the business section of a daily newspaper. "Company A has a large share of the international market in video-game hardware and software. Company B, the pioneer in these products, was once a $12 billion-a-year giant but collapsed when children became bored with its line of products. Thus Company A can also be expected to fail, especially given the fact that its games are now in so many American homes that the demand for them is nearly exhausted."
Confounding	Hey you! I have a doctor's appointment next Monday in Columbia that I cannot miss! I usually work from 12:00-4:45 and would really appreciate if you could fill in at any time. I am trying to make it back in time, hopefully by 2 or 3, and would be happy to take over. If you are available, just let me know!
Cooperative	Company B may not have been innovative. The product market for technology is highly dynamic and continually changing. Therefore, it is important to continually seek out new and original products to keep up with an evolving society.

Messages were created through a multi-step process. For conflicting messages, the PI put together a team of 20 undergraduate students. During the course of the semester, the students were given an assignment to find messages from their own personal work experience that fit the following criteria: 1) they found the messages to be off-task, 2) the messages were approximately three to four lines of text, 3) the messages did not have any pictures or sound, 4) the messages did not have any hyperlinks, and 5) the messages must not be higher than PG-rated[3]. During the semester, the teams individually sent in their messages. The PI carefully went through each message to double check them for meeting the criteria.

Once the primary task was determined and pretested, the PI formed all of the cooperative messages to help accomplish the task (see Table 4-9). These messages needed to follow the same guidelines as off-task messages, but they needed to be related

[3] They were encouraged to change the names of the senders and recipients of their personal messages to protect both the senders and receivers privacy.

to and assist with the work at hand. This way, the subjects would handle the messages as if they came directly from someone who could help them finish their task.

Once the two message banks were created, the messages were evaluated through a pretest using the following procedure. First, the team was instructed to say any message aloud that did not fit the criteria. Then, further examination was given to these noted messages. At the end of the episode, the PI went over the noted messages with each individual for further clarification of their response. Finally, messages that did not fit were discarded. For example, one message suggested that “In order to increase your chances of a good score—you need to write as much as you possibly can.” While this is a good tip to have while writing essays, because the subjects did not feel the message was accurate, the message was discarded to eliminate confounding relationships.

Table 4-10 presents the scale used to gain the individual’s perceptions about the messages level of support, whether confounding or cooperative.

Table 4-10 Message Profile
Below are listed a number of statements which are used to describe the demand you received during the task. Please read each statement carefully and indicate the extent to which each is an accurate or an inaccurate description of your amount of workload during the task.
Thinking about the interruptions you received while completing the task, answer the following questions.
Measured from Strongly Disagree (1) to Strongly Agree (5).
The interruptions helped me accomplish my task.
The interruptions came from someone with knowledge about my task.
The interruptions helped me think about my task.
The interruptions were not related to my task.

4.3.6.2 Control–Based Manipulations

We modeled three forms of control, including one primary control and two coping behaviors, which moderate the influence of demand stressors. They include timing control, method control, and resource control. Timing control is determined at the primary appraisal of the stressor and, therefore, occurs alongside demand. This form of control was measured in Experiment 1. Method control and resource control are coping behaviors and, therefore, were enacted only if stress was felt[4]. In Experiment 1, timing control was examined at two levels, low (email client with control) and high (email client with pop-up functions).

Timing control refers to whether the individual can decide when to view messages, rather than responding to intruding ICTs. This suggests that timing control is the individual's primary control over when the technology intrudes. In the experiment, a controlled environment is one in which the interruptions were administered through an email client that provided the participant the option to choose when to view a message. Having lower timing control makes it possible for individuals to experience more frequent and more intrusive interruptions. In our experiment, a low controlled environment is one in which the interruptions were administered by the same email client but had different settings that were more intrusive by design. This condition was intrusive

---

[4] Both of these coping behaviors were measured in Experiment 2 and are left out of the Experiment 1 discussion.

through timing because the message popped up on the screen. In terms of the subjective appraisal of timing control, the items adapted from Wall (1995) are shown in Table 4-11.

Table 4-11 Timing Control Scale
Below are listed a number of statements which are used to describe the amount of control you experienced during the task. Please read each statement carefully and indicate the extent to which each is an accurate or an inaccurate description of your experience during the task.
Measured from Very Little (1) to Much (5).
How much control did you have over when to check your messages?
How much did you set your own pace to read messages?
How much did you choose when to read your messages?

4.3.6.3. Perceptual Stress: Episodic Overload, Ambiguity, and Conflict

Perceptual stress refers to the characteristics of an episode in which the individual perceives adverse consequences. Perceptual stress is comprised of three dimensions: overload, conflict, and ambiguity. The dimensions of perceptual stress represent the first set of outcome metrics that result from the interaction between the characteristics of ICT-enabled interruptions and the level of timing control over the interruptions. Overload is defined as perceiving too many interruptions in a given time period. Conflict refers to perceiving an incompatibility in the demand requirements, where ICT-enabled-interruption-based demands conflict with task-based demands. Ambiguity refers to feeling uncertain about the behaviors associated with ICT-enabled interruptions. This form of perceptual stress can arise from either the interruption itself—i.e., how ambiguous the processing of interruptions is (interruption ambiguity)—or it can occur through the message causing the interruption—i.e., how ambiguous the message is (message ambiguity). Thus, it is clear that stress is multidimensional in nature, formed of overload, interruption ambiguity, message ambiguity, and conflict.

Through the transactional model, certain objective stressors create stress by influencing one or more of these perceptual dimensions, which then unequally influence objective strain. Therefore, as discussed in Chapter 3, overload, ambiguity, and conflict have different antecedents, and these perceptual dimensions do not have to influence objective strain equally. We must note the distinction between these perceptual stress items and the manipulations presented in the above few sections. Manipulations simply check whether the manipulation was perceived, while these items are reflective of a perceptual construct. Every attempt was made in creating the items to distinguish between the assessments of the manipulations and the stress received from those same manipulations. The perceptual stress scale derived from Moore (2000) and adapted to the interruption context is shown in Table 4-12.

Table 4-12 Perceptual Stress Scale
Below are listed a number of statements which are used to describe your feelings about stress during the task. Please read each statement carefully and indicate the extent to which each is an accurate or an inaccurate description of your amount of workload during the task.
Thinking about how you felt during the task, answer the following questions.
Measured from Strongly Disagree (1) to Strongly Agree (5).
Overload
I felt overloaded because I received more interruptions than I could process.
The interruptions made me feel rushed.
I felt busy due to interruptions.
The interruptions increased the pressure I felt to get done on time.
Conflict

I felt tension because interruptions were not relevant to completing the task.
I felt conflicted because many interruptions did not help me accomplish the task.
I felt stress because I received interruptions that clashed with my task.
Ambiguity
Message Ambiguity
The messages made me uncertain because they contained information that was not relevant to the task.
The information in the messages made me feel uncertain about what to do.
I was not clear about what I should do with the information in the messages.
I felt that the content in the messages confused me on how I should complete the task.
Interruption Ambiguity
I knew what had to be done with the interruptions.
I felt certain about when to expect interruptions.
I felt sure when to process interruptions.
I felt certain about how to respond to interruptions.

4.3.6.4. Outcome Measures

To test the outcomes of the episodic stress process, we relied on advanced tools that transmit stress measures more accurately. These tools non-invasively capture various indicators at designated intervals. The tools are presented in Table 4-13. Excessive stress can have a number of reactions on the body (Cohen & Williamson, 1991) some of which include increased stomach acids or increased production of blood sugar for energy. Other reactions include increased metabolism, such as faster heart rate and faster respiration. When stress is prolonged, people may also experience an everyday increase in blood pressure and cholesterol as well as a decrease in protein synthesis (i.e., digestion) (Shaw et al., 1991). Past experimental designs capture changes in alpha-amylase levels, blood pressure changes, and pulse rate as proxies for stress (Dickerson et al., 2004; Perrewe et al., 1989).

Table 4-13 Strain Measures		
Tool	Type	Measure
Salivettes	Salivary Stress Measure	Alpha-Amylase
Blood Pressure Machine	Common Stress Measure	Blood Pressure and Pulse rate
Subjectivity	Perceptual	Perceptual Strain

Salivettes are a valid tool for capturing salivary stress measures, such as alpha-amylase and cortisol (Rohleder et al., 2006). Stressors activate the hypothalamic-pituitary-adrenocortical (HPA) axis, which initiates the release of corticotrophin releasing hormone. This stimulates the anterior pituitary to secrete the adrenocorticotropin hormone, which then triggers the adrenal cortex to release cortisol into the bloodstream and saliva (Dickerson et al., 2004). Alpha-amylase is the precursor to cortisol and generally peaks fifteen minutes before an increase in cortisol. After the stressor discontinues, it takes five minutes for alpha-amylase to peak and twenty minutes for cortisol levels to peak (Granger et al., 2007). Forty minutes after the end of the stressor, the subject's levels return to normal. Both cortisol and alpha-amylase are common measures in health studies; however, alpha-amylase has been shown to be more appropriate for episodic increases. After valid pilot testing, we decided to use the alpha-amylase measure as the gold standard for episodic stress, which proved to be superior to cortisol[5].

[5] Cortisol is a better measure of chronic stress and has less episodic variance than alpha-amylase.

To administer the test, subjects opened a tube and dropped a cotton-roll-like substance (salivette) into their mouth. Subjects were instructed to put the tube up to their mouth, tilt their head back slightly, and drop in the cotton roll, while avoiding avoided using their hands or actually touching the cotton roll. They were instructed to swish the roll around in their mouth while refraining from chewing or putting it against their cheek. After two minutes, they took the cotton ball out by putting the empty tube up to their mouth and rolling it out with their tongue. Then, they closed the tube and passed it to the PI who put the tube in a zipper-top bag.

Samples were immediately frozen after each participant had completed the experiment at negative 20 degrees Celsius. While negative 80 degrees Celsius is best for retaining samples for longer than one year, negative 20 degrees Celsius ensures the short-term stability of samples (Garde & Hansen, 2005). Once all of the samples had been collected and frozen, we packed our samples in dry ice and shipped them through Federal Express (a hazardous materials/HAZMAT-certified shipping company) to the Salimetrics assay company to parse out the salivary hormones (Salimetrics, 2008)[6]. Samples were labeled according to specific regulations, and no individually identifying information was associated with the salivettes.

---

[6] The PI was also HAZMAT certified prior to collecting and shipping samples. Because certification is required to handle saliva, she was always present to take on that role formally.

Blood pressure cuffs were used to measure blood pressure and pulse rate. This technique is commonly used in organizational behavior stress research (Perrewe, 1987; Perrewe et al., 1989). Many factors contribute to high blood pressure (Matthews, Woodall, & Allen, 1993). Although there is still some confusion surrounding the issue of why high blood pressure occurs, several factors have been identified that collectively contribute to a greater understanding of this bodily process (American Heart Association, 2008). Even though researchers are not sure as to the precise causes of high blood pressure, they do agree that many factors contribute to high blood pressure (Matthews et al., 1993). Other contributors (besides stress) to high blood pressure include obesity, high sodium intake, high alcohol consumption, lack of physical activity, race, family, and age. Our study is *only* interested in examining the effects of ICT-induced stress on blood pressure. We empirically isolated the increase in blood pressure from stress by controlling for all steady factors (obesity, diet, alcohol consumption, etc.) and limiting other dynamic factors (exercise). We did this by taking the difference between individuals' pre-stressors and post-stressors to capture a change in their stress. Although each person's level of response to stress is different, by administrating this comparison test, we could accurately gauge the increased effects from the episode. We also clearly documented visible characteristics about each participant (i.e., healthy weight).

To administer the blood pressure tests, subjects were instructed to put a cuff on their left arm and relax with their arm resting on a flat surface parallel to the floor. Once the cuff was appropriately placed, the investigator pushed start on a digital reader. The cuff inflated until readings were determined. Each reading took approximately 30 seconds per participant to capture.

Alongside objective measures of stress, we also gathered perceptual outcomes of strain. Five items make up the perceptual strain scale derived from Moore's (Moore, 2000) work exhaustion scale. However, because our study only examines episodic effects, we adapted this scale to the episodic interruption context. Our adapted scale is shown below in Table 4-14.

Table 4-14 Perceptual Outcomes Scale
Below are listed a number of statements which are used to describe your feelings about strain do to the task. Please read each statement carefully and indicate the extent to which each is an accurate or an inaccurate description of your feelings as a result of the task.
Thinking about how you felt as a result of the task, answer the following questions.
Measured from Strongly Disagree (1) to Strongly Agree (5).
I was drained mentally.
I suffered from fatigue.
I felt tired.
I was strained.
I felt burned out.

We must note that because alpha-amylase directly captures the stress hormone, it is the state-of-the-art measure for stress research. Therefore, while we captured other metrics of strain, the results that occur from alpha-amylase are far more reliable than the remaining measures.

4.4. Experiment 2

4.4.1. Experimental Design

Figure 4-4 presents the research model that Experiment 2 tested.

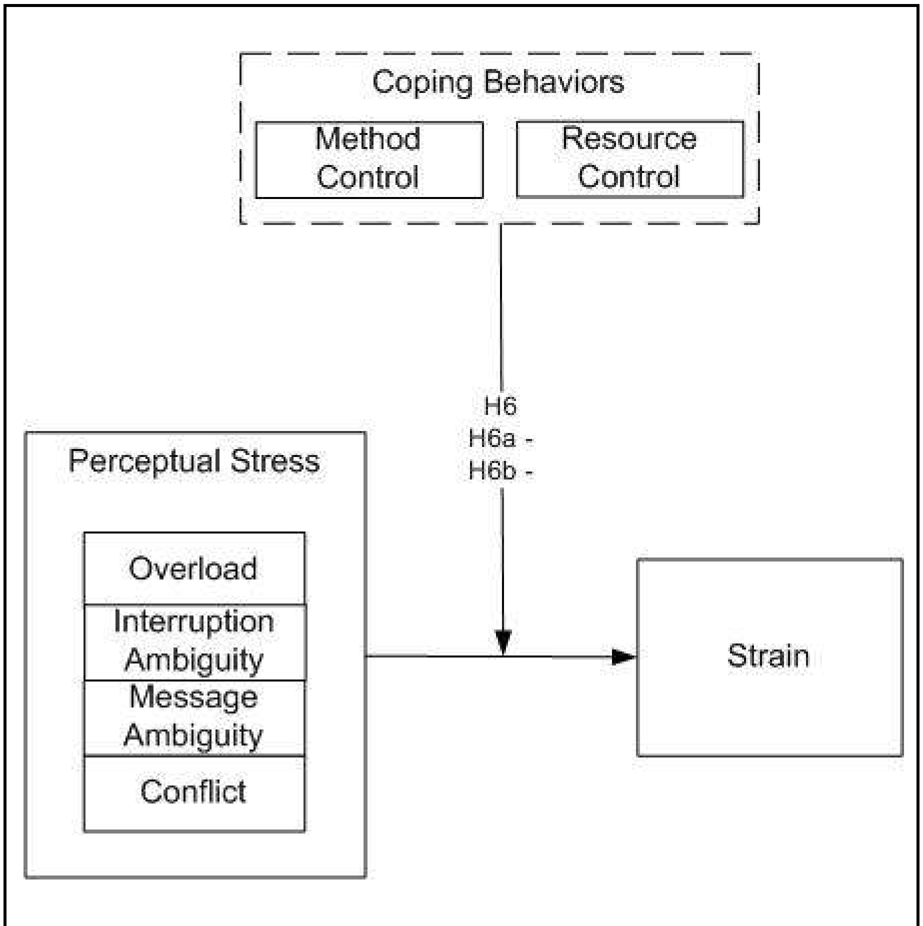


Figure 4-4 Experiment 2: Research Model

In this section, we explain the experimental conditions, design notation, factor structure, sample size, and measurement of the constructs used in the Experiment 2, including the manipulations of the coping behaviors, the perceptual variables and their associated items, and the objective outcomes. The coping behaviors were measured at two levels: 1) through a comparative analysis of coping and non-coping and 2) through items about the participants' feelings from actually performing the behaviors. Perceptual stress variables were measured using questionnaires, and the outcome strain variables were measured using objective indicators: alpha-amylase levels, blood pressure, and pulse rate. The objective indicators, perceptual variables, objective outcomes, and their associated scales are presented in this section. Appendix 2 presents the formatted survey used in the experiment.

4.4.2. Experimental Conditions

As suggested above, the experimental conditions are the factors we manipulated in the experiment, which were derived from the objective indicators we discussed in Chapter 3 (i.e., the independent and moderating variables) (see Table 4-15). For Experiment 2, we were interested in examining participants' coping behaviors, which only occur in a high-stress environment. Therefore, we set all of the other factors that contribute to stress at high.

Table 4-15 Experimental Conditions

Category	Variable	Experimental Manipulation
Demand Stressor	Quantitative Demand	*Controlled Factor:*
		High number of interruptions
Demand Stressor	Demand Variability	*Controlled Factor:*
		Variable interruptions
Demand Stressor	Message Profile	*Controlled Factor:*
		Confounding–not supportive
Primary Control	Timing Control	*Controlled Factor:*
		Email client with pop-up functions
Coping Behavior	Method Control	*Manipulation:* No option to use extra informational sources
		Manipulation: Option to use extra informational

		sources
Coping Behavior	Resource Control	*Manipulation:* No option to take a break
		Manipulation: Option to take a break

4.4.3. Design Notation

Experiment 2 tests the coping behaviors by setting the four previous factors manipulated in Experiment 1 at high, allowing us to isolate the effects of coping. In this experiment, coping is measured at two levels: level 1: between factor—having the option to cope and level 2: within factor— actual coping.

As shown by Table 4-16 there are two lines of notation, meaning that there are two groups. The R at the beginning of each line indicates that individuals are randomly assigned.

Table 4-16 Design Notation: Experiment 2

Group Number	Random Assignment	Observation Pre-Treatment	Treatment	Observation Post-Treatment
		Time →		
1	R [a]	O	X[bcd]	O
2	R	O	X[e]	O

[a] R1 denotes random assignment
[b] Quantitative demand, demand variability, message profile, timing control are set to high.
[c] Allowing subjects to have the option to enact resource control
[d] Allowing subjects to have the option to enact method control
[e] No coping options provided

4.4.4. Factor Structure

Table 4-17 shows the factor structure of the incomplete block design for Experiment 2. During the experiment, the subjects were randomly placed into a group until the appropriate sample size was reached. By enforcing a random design, we can assume that everything is equal except what we are directly manipulating (Trochim, 2004).

Table 4-17 Factor Structure: Experiment 2	
Group 1	Group 2
HIGH Stress* - No Coping	HIGH Stress - Coping
*In high-stress environments - QD = High; DV = High; MP=High; TC = High	
Coping behaviors are evaluated on two levels: 1) as the option to cope and 2) as enacting the coping behaviors.	

To measure perceptual outcomes, we gathered the subjective metrics after each episode. To measure strain outcomes, we gathered the objective measures before and after each episode in order to calculate the episodic increase for each observation.

4.4.5. Sample Size

We conducted a power analysis to approximate the sample size needed for Experiment 2. In experimental design, the number of groups from the design notation serves as a basis for the power analysis. This enables us to see what number of observations would provide us with a sufficient power to detect the appropriate response.

Experiment 2 tests two groups such that the coping group has two within variables: resource and method control. To determine the sample size for each study, we ran a power analyses through G-power software (see Table 4-18). We found that a sample size of 64 subjects would give us an approximate power of .80, an appropriate power for the experimental design (Cohen, 1992). Since Experiment 2 is based on the outcomes of the within variables' (i.e., the coping behaviors) interaction with the between variables (stress), the required sample size per group was much higher than for Experiment 1, which only tests between variables. Just as in Experiment 1, the difference in stress/strain readings between the two time periods (time 1 and time 2) will form the measure of the observation.

Table 4-18 G-Power Analysis: Experiment 2			
F tests - MANOVA: Repeated measures, within factors			
	A priori: Compute required sample size		
Input	Effect size f	=	0.25
	α err prob		0.05
	Power (1-β err prob)		0.80
	Number of groups		2
	Response variables		2
Output	Noncentrality parameter λ		8.25
	Critical F		3.99
	Numerator df		1
	Denominator df		1
	Total sample size		64
	Actual power		0.807569
MINIMUM Sample Size needed: 64			

4.4.6. Construct Measures

4.4.6.1. Perceptual Stress: Episodic Overload, Ambiguity, and Conflict

Perceptual stress refers to the characteristics of an episode in which the individual perceives adverse consequences. Perceptual stress is comprised of three dimensions: overload, conflict, and ambiguity. In Experiment 2, we set the objective conditions that evoke perceptual stress to high, so we could further evaluate the effects of coping behaviors on strain. As suggested in Chapter 3, the individual aggregates the dimensions of stress into an overall feeling during the secondary appraisal (e.g., “I feel stressed and need to cope”). We also suggested that coping must take place after a secondary appraisal has been made. Therefore, the individual has already aggregated the dimensions of stress in their mind before coping behaviors can begin. As such, we aggregated the dimensions of stress into one unified construct, perceptual stress. Therefore, we were far less interested in the multidimensional nature of stress in Experiment 2 as we were in Experiment 1. Experiment 2’s perceptual stress scale derived from Moore (Moore, 2000) and adapted to the interruption context is consistent with Experiment 1, which was presented in Table 4-12.

4.4.6.2 Coping Measures and Manipulations

We measured two coping behaviors that capture the implications of the secondary appraisal: method control and resource control[7]. Method control refers to when the individual chooses to change how they carry out the work. As a manipulation, method control gave the subjects the ability to cope with high demand by providing them with the option to use extra informational sources that aided in their completion of the primary task. Therefore, if participants perceived stress at the primary appraisal, but also used coping abilities as a result of the secondary appraisal, they could have less strain than if

---

[7] See Appendix 6 for screenshots of these coping behaviors in action.

they did not have the coping option available to them. The scale adapted from Wall (1995) is shown in Table 4-19.

Table 4-19 Method Control Manipulation
Below are listed a number of statements which are used to describe the amount of control you experienced during the task. Please read each statement carefully and indicate the extent to which each is an accurate or an inaccurate description of your experience during the task.
Thinking about the method you used to complete the essay, answer the following questions. To what extent did you have …
Measured from Very Little (1) to Much (5).
access to different ways to collect the information required to complete your task.
control over which sources of information you needed to do your job.
access to the Internet to complete tasks.
the sources of information you needed to accomplish the task.

Resource control refers to having and enacting the option to relax from the ICT environment and engage in off-task behavior. As a manipulation, resource control allowed participants to have the option to take a break from the ICT environment. Moreover, the group that had resource control had built in slack time that allowed them to choose whether they wanted to relax from the stressors when demands were high and stress was felt. The manipulation check for resource control is shown below in Table 4-20. Item 4 was adapted from Dwyer (1991). The other items were created and validated through the pretests and the pilot analyses.

Table 4-20 Resource Control Manipulation
Below are listed a number of statements which are used to describe the amount of control you experienced during the task. Please read each statement carefully and indicate the extent to which each is an accurate or an inaccurate description of your experience during the task.
Measured from Very Little (1) to Very Much (5).
I was provided the time to take an efficient break.

I had the option to take time off from the computer.	
I had control over if I took a break.	

4.4.6.3 Objective Outcomes

To test the outcomes of the episodic stress process, we relied on advanced tools that transmit stress measures more accurately. We presented information on our objective outcomes in Section 4.3.6.4.

4.5. Experimental Controls

Researchers have proposed that the inconsistency of empirical findings with regards to the demands control model is due to researchers' failure to consider individual differences (Perrewe, 1987). However, this study controlled for the effects personal characteristics have on the stress process. Based on past findings in the literature, we controlled for the effect positive and negative affectivity (Watson & Clark, 1984; Watson, Clark, & Tellegen, 1988) has on stress. In addition, since our design revolves around ICT ability, we also gathered a measure for participants' Internet usage. The formatted survey of the control variables is located in Appendix 3. This survey is divided into two sections: Appendix 3a and 3b. Appendix 3a asks for the control variables associated with the episode (i.e., positive and negative affectivity), and Appendix 3b reflects the control variables associated with participants' personal characteristics (Internet usage, age, gender, etc.).

Stress can be further understood by an individual's emotions because an individual's positive and negative affects can influence their perceptions of stress. The positive and negative affect scale (PANAS) adapted from (Watson et al., 1988) is presented in Table 4-21. This 20-item question is comprised of two scales, positive affect (PA) and negative affect (NA), which collectively control for extraneous variance in stress. While these scales are gathered together, they are viewed as distinct because of their different correlates (Watson & Pennebaker, 1989). PA refers to an individual's positive feelings, such as alertness and excitement. When individuals are have high PA, they are more likely to experience high energy, concentration, and pleasurable engagement, whereas individuals with low PA are more likely to be sad and lethargic (Watson et al., 1988). PA is associated with a wide range of events, most notably of which include social activities (Watson et al., 1989). NA is the individual's disposition to experience discomfort and negative emotional states across time (Agho, Price, & Mueller, 1992; Watson et al., 1984). NA can also be categorized as an individual trait that predetermines an individual's likelihood to feel guilt or shame after an episode (Thatcher & Perrewe, 2002 128). In this sense, individuals high on NA are more inclined to experience higher levels of stress, regardless of the situation, than individuals high in PA, and they are also more likely to maintain those high levels for a longer period after the episode (Watson et al., 1984). Therefore, we control for the influence PANAS has on stress.

Table 4-21 The Positive and Negative Affect Scale

Measured from Very Slightly or Not at All (1) to Extremely (5)	
_______ distressed	_______ alert
_______ excited	_______ ashamed
_______ upset	_______ inspired
_______ irritable	_______ determined
_______ jittery	_______ attentive
_______ strong	_______ active
_______ guilty	_______ afraid
_______ scared	_______ enthusiastic
_______ hostile	_______ proud
_______ nervous	_______ interested

Internet usage was captured in order to control for subjects' general experience level with using the Internet. This has been widely used as a control variable in previous technological experiments. We believe that the more experience an individual has using the Internet, the easier he/she can handle ICT-driven demands and control. Based on this assumption, we collect Internet usage as a control. Table 4-22 shows the items used.

Table 4-22 Internet Usage Scale
Measured from < 6 months (1) to > 8 years (5).
How many years have you used the Internet?
Measured from Much (1) to Little (5).
How often do you use the Web to search for information?

Finally, we also gathered demographic variables, while holding constant the physical environment, to control for extraneous variation. For demographics, we captured gender and age to test for differences in the model. In holding the physical environment constant across participants, we controlled for the laboratory setting, lighting, noise, temperature, seat number, and time of day the study took place. Finally, since we were gathering objective stress measures, we also controlled for alcohol usage, caffeine usage, and dairy intake in addition to whether the participant had eaten a meal 60 minutes prior to the experiment. Figure 4-5 presents pictures of the laboratory used to run all subjects.

Figure 4-5 Laboratory

4.6. Analysis

The analyses used in this study are presented and discussed in this section. Figure 4-6 details the plan for data analysis. It shows four stages: pretest, pilot, experiment, and results. The pretest is discussed in this section to provide our initial findings on the experiment. The pilot, experiment, and results sections will be set up in this chapter but will be discussed more formally and analyzed in the next chapter. To analyze our data, we use multivariate analysis of variance (MANOVA) and multivariate analysis of covariance (MANCOVA) to test our hypotheses. This is a practical method frequently used in experimental design.

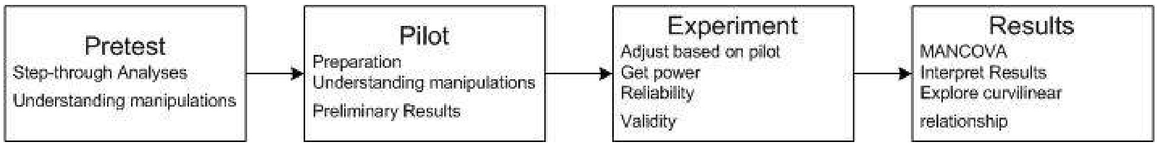


Figure 4-6 Analysis Walk-Through

4.6.1. Pretest— Initial Findings

The pretest was exploratory and was used to calibrate the measures of our variables. This was the first preliminary stage in which we administered a step-through analysis with participants and refined our manipulations and survey questions. The step-through with the PI allowed participants to talk aloud and provide detailed feedback as necessary. There were two phases of the pretest, and each phase was administered to the same participants in order to compare *if* and *why* they felt one phase caused a higher level of stress.

The pretest included 23 participants who participated two times (one time in each phase): 1) under a high demanding and low control situation and 2) under a low demanding and high control situation. These members had previously participated in the think tank and were familiar with the criteria under investigation. Therefore, they were better enabled to provide helpful pointers during the pretest. The participants were instructed to talk aloud and provide feedback as necessary. To maximize the utility from the pretest, at the end of both sessions, we administered a survey to help validate our measures and check our manipulations.

In terms of quantitative demand, the first phase varied in the numbers of interruptions it had: one every 15 seconds, 18 seconds, 20 seconds, 24 seconds, 30 seconds, and every minute. Through focused interviews with participants directly following the experiment, we determined that one interruption every 20-24 seconds was still very demanding; however, it allowed the subjects to finish their primary task. When the number of interruptions was more frequent than every 20seconds, the participants had a difficult time setting up the groundwork to begin their task (i.e., the start their essay). When the number of interruptions occurred less frequently than every 24 seconds, the participants informed the PI that they did not feel the stress from a high demand. We concluded that receiving a message every 20 seconds was highly demanding and anything less frequent than 24 seconds was closer to moderate demand. After further analysis, we found that for moderate quantitative demand, one interruption every minute was still associated with demand, but the task was more easily accomplishable with less stress than if there was greater than one interruption per minute.

Demand variability was not directly calculated in the pretest. However, during some of the trials, because interruptions were sent manually, the instructor sending the messages was instructed by the PI to send them randomly without keeping a timer. According to their interviews, participants who experienced variability in demands appeared to be more overloaded than participants who could establish a flow in receiving the interruptions; however, the exact effect was difficult to determine without a more systematic automation in place.

In terms of confounding verses cooperative messages, the students were able to determine the helpful messages. Prior to starting the pretest, the subjects were instructed that some messages were from the PI while others were from their peers. During the interviews, the subjects informed the PI that her on-task messages were helpful by providing statements like *the interruption helped*: “jumpstart my thinking” or “make me think outside the box” or “confirm some ideas I had.” In some cases, students even took the PI’s thoughts and recreated them to input directly into their task.

In terms of timing control, in many cases, the subjects were able to feel the effects of this manipulation (i.e., “I felt that having control over when to check my messages saved me because it allowed me to finish my thoughts before I continued on.”) Many interview responses centered on “continuous thought,” “less intrusion,” and “more control.” This ensured the researchers that the timing control manipulation was a strong manipulation that was identifiable to participants and was associated with varying levels of stress.

In terms of method control, subjects with method control were given free reign over the Internet to help them accomplish their task. At the end of each pretest, subjects were asked if they used any additional sites, why they did so, and if it help them start their thinking. The subjects that enacted the option did so to help them cope with the demand. These subjects were more threatened by the level of demand and needed to find alternative ways of dealing with the persistent discontinuity.

In terms of resource control, some subjects were given the option to take a two minute break to relax and log off. None of the subjects took advantage of this option when demand was low. They informed the PI with reason for their choices with statements like “there was no need” or “I was on roll.” It was determined that subjects who were able to establish a continuous relationship with the task had no need to cope. On the other hand, when subjects were in high-demand situations, they needed to enact the resource control. They informed the PI that because the interruptions were occurring at such a fast rate, there was no time to collect their thoughts and form cohesive statements. Therefore, resource control was confirmed to be an emotion-focused coping behavior in which the subjects in need escaped from the technological environment to relax.

To maximize the utility from the pretests, at the end of each phase, we administered a survey to help validate our measures and double-check our manipulations. We could determine from the survey whether participants could easily understand the items and whether they were appropriate. The PI took the surveys and individually interviewed the subjects on 1) their general feelings of the pretest and 2) why they responded the way they did (i.e. “Why did you put a 4 under high temporal demand if you thought it was less demanding than the your first run-through”). Overall, this stage of analysis helped prepare the experiment prior to saliva sample collection to ensure that there were no mistakes. Since laboratory work is expensive to process, this was a critical stage help the PI get a general *feeling* of the way the conditions would work in the next preliminary step.

4.6.2. Pilot

The pilot is the second preliminary stage of the experiment in which we began to understand the usefulness of the manipulations. This stage used full protocol and gathered samples from subjects. Here we determined if there were timing issues concerning sample collection and which salivary measure was superior for episodic manipulations. This stage involved 19 undergraduate students.

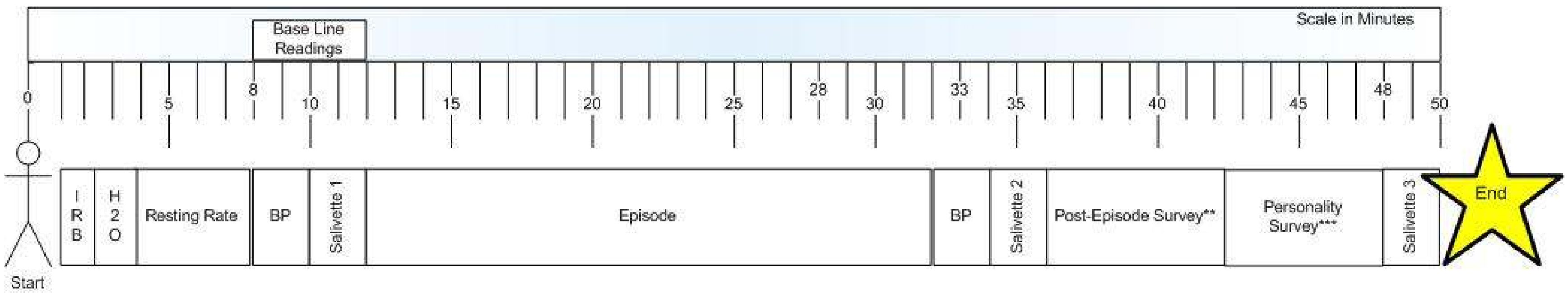
During the pilot, we collected and analyzed more objective measures from pilot participants, including both cortisol and alpha-amylase measures. Prior to being allowed to begin the experiment, the participants were informed of their rights and agreed to the study by signing the approved IRB letter (See Appendix 4). Figure 4-7 depicts the flow of the pilot. The pilot was different from the final experimental protocol presented in Section 4.2.4. in 2 main ways. First, the pilot called for the collection of both cortisol and alpha-amylase, where the final protocol only called for the collection of alpha-amylase. For the baseline reading, the saliva from the salivette was extracted and divided into cortisol and alpha-amylase at the laboratory once the samples were shipped. After the episode was complete, because the timing was different post-stressor, we collected saliva samples at two different points in time – 5 minutes post-stressor for alpha-amylase and 20 minutes post-stressor for cortisol.

Second, during the pilot, all surveys were conducted after the episode, where the final protocol was adjusted to collect survey demographics variables before to the episode began. Therefore, following the administration of the 2nd salivette, we gave participants a short survey of perpetual demands, control, outcomes, and episodic control variables (i.e., PANAS) (see appendix 2 and 3a). Then, fifteen minutes after the first set of objective readings (20 minutes after the episode ends), subjects repeated the salivette test to retrieve the level of cortisol response. Finally, we administered the survey of dispositional and demographic control variables, including Internet usage, gender, age, meal, dairy intake, caffeine usage and alcohol usage (see Appendix 3b).

From the survey data, we calculated Cronbach alphas' of the constructs and carefully went through the instrument. After careful analysis, we changed six items that were the cause of low alphas. We also modified construct items that resulted in extraordinarily high scores (.97 or greater) because we determined that we were measuring the same thing with each item as opposed to tapping into a wider spectrum of the construct. This only occurred with items for perceptual overload and perceptual conflict[8].

---

[8]Because we made changes to the survey during the pilot, we reran the reliability analysis on all items after collecting 50 more data points during the full experiment. Once we decided that their values were acceptable, we concluded that the items were valid and reliable.



* Salivette 1 is for alpha-amylase and cortisol levels

Salivette 2 is for the level of alpha-amylase

Salivette 3 is for the level of cortisol

** Survey includes manipulation checks for quantitative demand, demand variability, message profile, timing control, method control, and resource control. It also includes items for overload, ambiguity, conflict, strain, and episodic control variable PANAS. See Appendix 2 and 3a for survey details.

*** Survey includes items for Internet usage, demographic variables, and stress hormone controls. See Appendix 3b for survey details.

Figure 4-7 Experimental Flowchart: Pilot

4.6.3. Experiment and Results

Informed by our pilot study, the full experiment took place in the fall and spring in 2008/2009. For the full experiment, we used our protocol to collect data from 180 undergraduates, established the validity of our measures, and tested our hypotheses. To improve validity, we ensured that the test had good statistical power, good reliability, and good implementation (Trochim, 2004). Because the data came from different objective sources, we also carefully checked the data for both outliers that resulted from a poor administration of the test and for data entry accuracy into the computer.

Finally, we analyzed the data and presented our results. In this stage, we tested the proposed hypotheses of each experiment. Our experimental designs allowed us to use MANOVA or MANCOVA to test our hypotheses with quantitative demand, demand variability, message profile, and timing control as the between subjects factors in Experiment 1; and method control and resource control as both between and within subjects factors in Experiment 2; and Internet usage, PANAS, gender, age, meal, dairy intake, caffeine usage, and alcohol usage as covariates for both.

4.7. Summary

This chapter proposed the research methodology used to test the hypotheses discussed in Chapter 3. We set up the study at the episodic level of analysis using experimental design. Then, we named our sample frame, discussed how we informed participants of their rights, and detailed the incentives used to motivate participants. After discussing the foundation for the study, we set up two laboratory experiments used to test the model. Here, we provided details about the measures used to evaluate stress and mapped out the experimental design for each experiment. Finally, we provided detail on the control variables used in the study and concluded with our preliminary analyses of the study. The next chapter will expound on these analyses by presenting the results found in the study.

Chapter 5. Results

5.1. Introduction

This chapter presents the results obtained from the two laboratory experiments. Figure 5-1 presents the organization of the chapter. We begin by first discussing the data collection procedures and descriptive statistics of the main sample. The next section reports the reliability and validity of the data. Then, we test the assumptions of experiment design. The chapter concludes with an analysis of the data and presentation of results. In this stage, we tested the hypotheses of each experiment using either multivariate analyses of variance (MANOVA) or multivariate analyses of covariance (MANCOVA) to test our hypotheses, with quantitative demand, demand variability, message profile, and timing control as the between subjects factors in Experiment 1; and method control and resource control as both between and within subjects factors in Experiment 2; and negative affect, gender, age, alcohol usage, caffeine usage, dairy usage, and time since last meal as covariates.

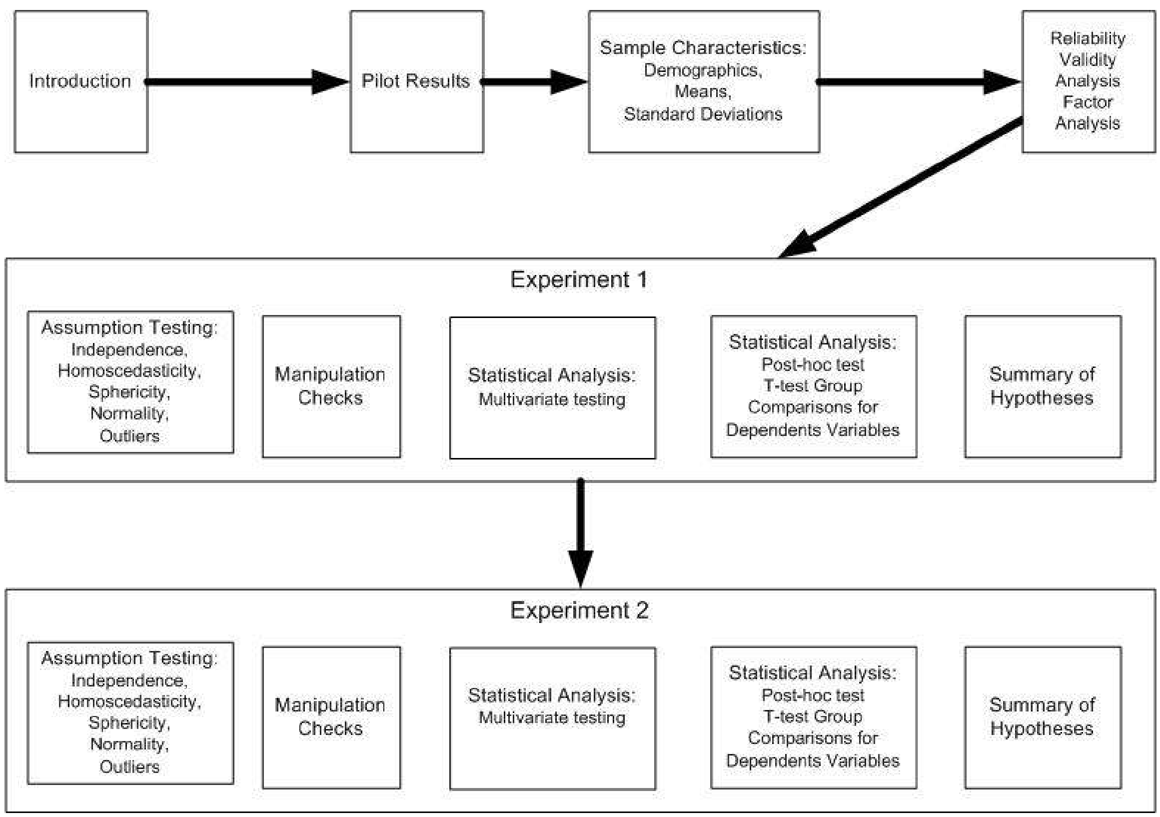


Figure 5-1 Chapter 5 Flowchart

5.2. Sample Characteristics

Overall, 180 students participated in the experiments. As discussed in Chapter 4, the sample was undergraduate students at a large Southern university that were active users on the Internet. Over 70% of our sample reported having used the Internet over eight years. Over 80% of our sample reported using the Web frequently. We concluded that our sample had extensive experience using the Internet.

Table 5-1 Sample Stratification					
Years Using the Internet	< 6 mo	>6 mo to 2 yrs	>2 yrs to 4 yrs	> 4yrs to < 8	> 8 yrs
	0.0%	0.0%	0.6%	28.3%	71.1%
Frequency in using the Web	Very Little	Little	Some	Often	Very Often
	0.0%	0.6%	0.6%	17.2%	81.7%

Table 5-2 shows the descriptive statistics of the sample. Slightly more men than women participated in the survey. The average age was slightly over 21, which is typical of college-aged students. The majority were Caucasian/non-Hispanic Juniors and Seniors. The GPA varied widely with just over fifty percent having a 3.0 or greater. Junior and Senior students who have maintained above a 3.0 were key targets for our study because our primary task was a writing task – and these students were more likely to comprehend what was being asked of them. Overall, our sample was comprised of demographics similar to those in all business schools.

Table 5-2 Demographics				
Gender			Male	Female
			61.10%	38.90%
Age			Mean	Standard Deviation
			21.14	2.03
Class Status	Freshman (0.0%)	Sophomore	Junior	Senior

	1.70%	26.10%	32.20%	40.00%	
Ethnicity	Caucasian/non-Hispanic	Hispanic	Asian	African-American	Other
	85.60%	1.70%	1.10%	10.60%	1.10%
Overall GPA	<2.0	2.0 and <2.5	2.5 and <3.0	3.0 and >3.5	3.5 or greater
	0.60%	18.30%	26.70%	36.10%	18.30%

Next, to preserve the quality of the objective stress measure, we ensured that our sample had not experienced a stressful act prior to entering the laboratory (See Table 5-3 for details of controlled stress inducing acts). Hence, subjects were instructed to not drink caffeine, alcohol or dairy, or eat a major meal before the experiment. After consenting to these conditions, subjects signed up for a time. Before the experiment, subjects were reminded by the investigator via email of the behaviors not recommended before participation. While it is best to avoid these contaminants all together, water was given to the subjects 10 minutes prior to collection to wash out the mouth in case some subjects disregarded the requests. Out of the 180 people processed, we only had one subject's salivettes come back with error (leaving the biometrics sample at 179). This could have been due to the contaminants, such as caffeine or alcohol, drying out the mouth preventing proper salivation.

Table 5-3 Stress Sampling Controls

Have you had alcohol in the last 24 hours?	No	1 drink	2 drinks or greater
	79.40%	6.70%	13.90%

Have you had caffeine in the last 2 hours?	No	Very Little	Some	A lot
	72.80%	17.20%	8.90%	1.10%
Have you had any dairy products or high fructose foods 20 minutes prior to the study?			No	Yes
			87.70%	13.30%
Have you eaten a major meal 60 minutes prior to the study?			No	Yes
			79.40%	20.60%

5.3. Reliability and Validity Analysis

The means and standard deviations for each of the construct are reported in Table 5-4. Since the survey had gone through rigorous pretesting, it was no surprise that the constructs did not exhibit any serious validity problems.

Table 5-4 Construct Means

Construct	Mean*	Standard Deviation
Perceptual Strain	2.4667	.80972
Overload	3.5625	.96838
Conflict	3.3870	.97209
Interruption Ambiguity	2.7542	.72103
Message Ambiguity	2.6722	.78671
Quantitative Demand	3.7556	.82131
Demand Variability	3.4958	.82131
Message Profile	3.6944	.6798
Timing Control	3.4796	1.23831
Resource Control	2.7870	1.33276
Method Control	3.4333	.98296
*Items Scale: 1 (Strongly Disagree) to 5 (Strongly Agree)		

The factor loadings, reliabilities, and number of items for the entire sample of 180 subjects are shown in Table 5-5. An assumption of multivariate testing is that the covariates must have low measurement error. When there is measurement error, the statistical power of the F-test decreases and there is more of a chance to find a type II error (rejecting the hypotheses when in fact it is true).

In order to test for measurement error, we conducted a confirmatory factor analysis of the constructs. Their item loading range is shown below (see Table 5-5). A detailed table with each item and their respective loadings is also provided in Appendix 5.Second, we calculated the Cronbach's alpha. This value should be greater than .7 before it can be combined for a scale; however, other researchers use the more lenient .6 (Garson, 2009). We only had one construct, interruption ambiguity, be lower than .7; however, because it was greater than .6 (.651) it was retained in the analysis.

Table 5-5 Factor Loading

Construct	Item Loading Range***	Cronbach's Alpha	Number of Items
Strain	.704 - .902	.892	5
Overload	.761- .895	.890	4
Conflict	.739 - .820	.825	4
Interruption Ambiguity*	.666 - .729	.651	4
Message Ambiguity	.501 - .775	.726	4
Quantitative Demand	.501 - .786	.794	4
Demand Variability	.483 - .877	.710	4
Message Profile	.637 - .829	.798	4
Timing Control	.599 - .820	.749	3
Resource Control	.771 - .878	.837	4

Method Control**	.740 - .833	.837	4
* Interruption ambiguity item 2 (IA2) was dropped from further analysis due to a low a factor loading of .311 ** Method control item 4 (MC4) was dropped from further analysis due to a loading of .391 *** All loadings that were not dropped were above or close to .5			

While common method bias is a common threat to behavioral science studies, it is less of a threat to experimental studies that use both objective and perceptual measures. Our design helped overcome method bias because in each case the two constructs being related were each captured with a different technique. Specifically, we manipulated the enabling technology and related it to perceptions (objective to perceptual). Then, we related the perceptual to objective outcomes. This technique significantly reduces our chance of biasing our results.

Pearson correlations use bivariate analyses to measure the strengths of association between two or more variables. This value always varies between +1 and -1. When the value approaches +1 or -1, the two variables are fully associated with each other. As the value approaches 0, the relationship between the two variables gets weaker. Table 5-6 shows the correlations between constructs.

Table 5-6 Pearson Correlations

	QD	DV	MP	TC	RC	MC	O	C	IA	MA	PS	BPd	BPs	AA	Pulse
Quantitative Demand (QD)	1.00														
Demand Variability (DV)	.211**	1.00													
Message Profile (MP)	.273**	.174*	1.00												
Timing Control (TC)	.246**	.269**	.297**	1.00											
Resource Control (RC)	-0.13	0.07	0.12	0.06	1.00										
Method Control (MC)	-0.01	0.06	.197**	.140*	.613**	1.00									
Overload (O)	.729**	.187**	.233**	.324**	-.198**	-0.01	1.00								
Conflict (C)	.598**	0.13	.305**	.239**	-.155*	-0.01	.766**	1.00							
Interruption Ambiguity (IA)	.311**	0.07	0.11	.148*	0.00	0.01	.319**	.259**	1.00						
Message Ambiguity (MA)	.461**	-0.04	0.12	0.02	-.132*	-0.05	.619**	.632**	.360**	1.00					
Perceptual Strain (PS)	.543**	0.01	.294**	.237**	-0.07	0.05	.593**	.559**	.169*	.482**	1.00				
BP Diastolic (BPD)	0.07	-0.02	-.144*	-.178*	-0.03	-0.05	0.01	0.12	0.09	.185**	0.01	1.00			
BP Systolic (BPS)	-0.01	0.00	0.02	-0.07	-0.03	-0.08	-0.04	-0.01	0.00	0.02	0.00	.254**	1.00		
Alpha Amylase (AA)	.165*	0.06	0.02	-0.03	-.152*	-0.08	0.05	-0.07	-0.02	-0.07	0.01	0.08	0.12	1.00	
Pulse	-0.016	-0.068	0.080	-0.051	-0.015	0.044	0.061	0.084	-0.015	0.020	0.032	0.131	0.214	0.105	1.00

**Correlation is significant at the 0.01 level.

*Correlation is significant at the 0.05 level.

Having established the reliability of the construct measures, we split the data by experiment to test the multiple models.

5.4 Experiment 1

To test the model presented in Chapter 4, we use either MANOVA or MANCOVA. The purpose of a MANOVA is to compare the groups formed by categorical independent variables with a set of dependent variables. MANCOVA relaxes the categorical requirements of the independent variables and allows for the processing of any covariates. To test our model presented in Chapter 4, we ran 3 different multivariate analyses: Model 1, Model 2, and Model 3 (See Figure 5-2, Figure 5-3, and Figure 5-4). Model 1 tested the hypotheses from the demand stressors to perceptual stress. Model 2 tested the interaction of timing control. Model 3 tested the hypotheses from perceptual stress to objective strain.

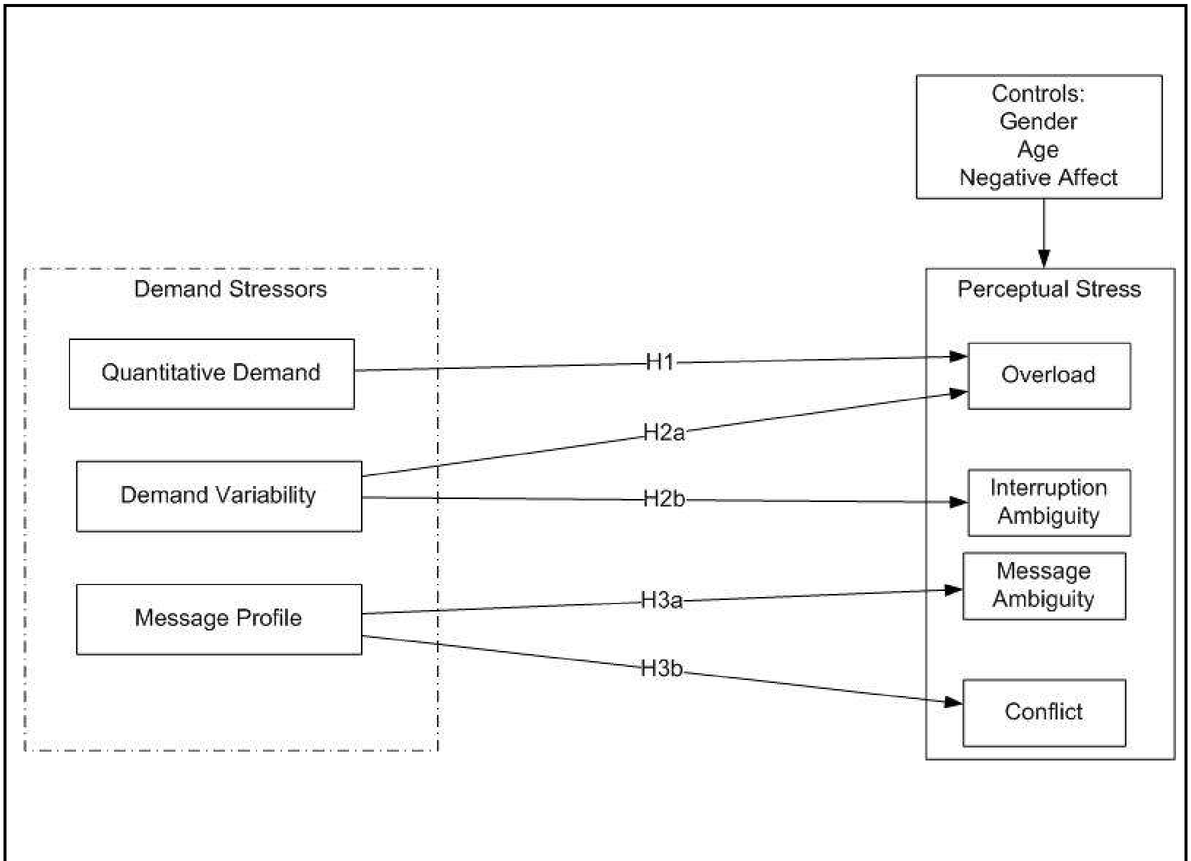


Figure 5-2 Experiment 1: Model 1

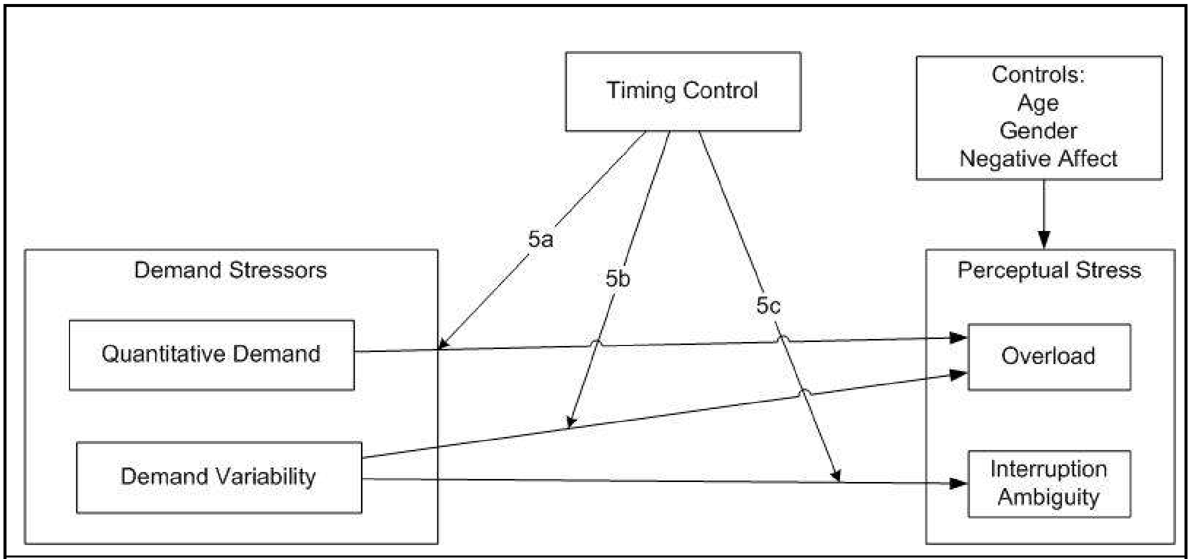


Figure 5-3 Experiment 1: Model 2

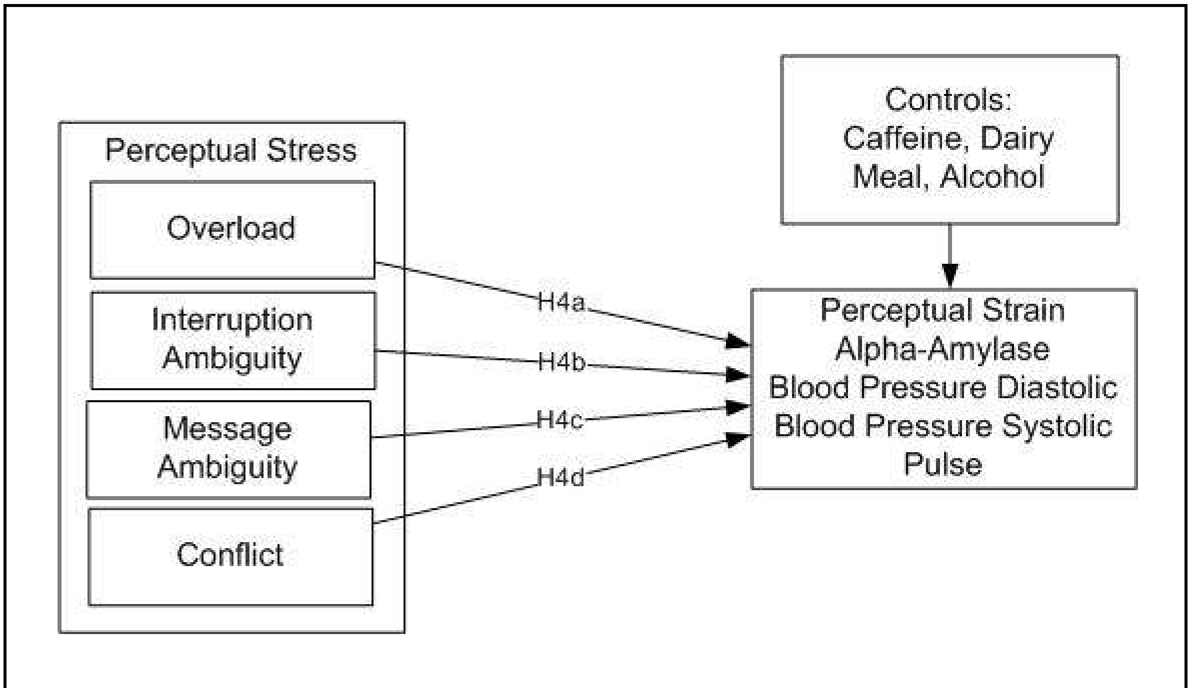


Figure 5-4 Experiment 1: Model 3

In Chapter 4, we presented the factor structure for testing these models. It is represented below (See Table 5-7). Group 1 was our "Low Strain" group. It has a low level of quantitative demand, demand variability, message profile, and timing control. Group 2 changes the level of quantitative demand to high, thus testing hypothesis 1 (that quantitative demand leads to perceptual overload). Group 3 has a low level of quantitative demand, but has a variable level of demand, thus testing hypotheses 2a and 2b. Group 4 had off task messages, thus testing hypotheses 3a and 3b. Groups 6 and 7 take away timing control, thus testing the interaction (hypothesis 5a, b, and c). Group 5 was captured in order to have a group with low demand stressors alongside no timing control. This was contrasted with the low demand stressors group with timing control (group 1). Group 8 was gathered to ensure that message profile did not have an interaction with timing control. This was compared to group 4, which had off-task messages and timing control. Groups 5 and 8 were not hypothesized, but were collected for exploratory research.

Table 5-7 Factor Structure

Message Profile							
On-Task							
Timing Control							
Yes				No			
Quantitative Demand	Low	Group 1	Group 3	Quantitative Demand	Low	Group 5	Group 7
	High	Group 2			High	Group 6	
Demand Variability		Low	High	Demand Variability		Low	High
Message Profile							
Off-Task							
Timing Control							
Yes				No			
Quantitative Demand	Low	Group 4		Quantitative Demand	Low	Group 8	
	High				High		
Demand Variability		Low	High	Demand Variability		Low	High

5.4.1. Assumptions

To ensure the accuracy of our results, we first test all the underlying assumptions. The first assumption is that the dependent variables are continuous and interval level. Each model was formed with continuous variables as dependent variables. Therefore, we conclude that we met this assumption.

The second assumption of MANOVA suggests that the independent variables must be categorical. The group variables were formed from the manipulations and were categorical (i.e., low vs. high), meeting this assumption for Model 1 and Model 2. Model 3 had continuous perceptual variables as independent variables. Instead of transforming these variables into categories, we tested this model as a MANCOVA, as opposed to a MANOVA. This allowed us to relax that assumption for general MANOVAs. Even though we ended up testing this model as a MANCOVA, all the other assumptions are identical between MANOVAs and MANCOVAs.

The third assumption states that the sample distribution must be normal. Table 5-8 presents the normality statistics after we deleted 4 outliers that were 3 standard deviations above the mean and exhibited skewness and kurtosis. After we deleted these outliers, the group 2 had 10 subjects, group 3 had 12 subjects, and the remaining groups all had 11 subjects. The remaining sample size of the study was 88.

The first step was to check for positive skew in the alpha-amylase values before entering them as the dependent variable in the model. To determine whether a value is considered skewed, we compared 2 times the standard error to the absolute value of the skewness. If it is greater than the skewness value, the data is considered normal. For example, group 1 had a value of -1.107 and a standard error of .687. We multiply the standard error by 2 to give us 1.364, which is greater than 1.107, thus pointing to normality. All groups were also considered normal.

We use the same numerical formula as skewness to evaluate kurtosis: by multiplying the standard error by 2 and seeing the value is greater than the absolute value of the kurtosis score. None of the groups appeared to show signs of kurtosis. Therefore, we concluded that the data is normal[9].

Table 5-8 Normality Tests							
Group Number	Skewness		Kurtosis		Shapiro- Wilk		Outliers Deleted
	Statistic	Std. Error	Statistic	Std. Error	Statistic	Std. Error	
1	-1.107	.687	.333	1.334	.955	.759	Case 6 Case 13
2	.528	.687	.208	1.334	.958	.768	Case 60
3	-9.43	.637	4.326	1.232	.973	.911	Case 162
4	.383	.661	-1.587	1.279	.914	.274	None
5	.912	.661	-.484	1.279	.907	.226	None
6	2.305	.661	5.657	1.279	.934	.451	None
7	1.048	.661	.243	1.279	.867	.071	None
8	.779	.661	-.750	1.279	.981	.973	None
Final Sample Size: 88							

The next assumption is homoscedasticity (homogeneity of variances and covariance). This suggests that the error variance of each interval dependent should be similar. To test this assumption we use the Levene's Test of Equality of Variances. Typically, each statistic should be non-significant in order to meet the assumption. Table 5-9 suggests that the majority of the model did not violate the assumption. Perceptual strain was significant at the .05 level but was insignificant that the .01 level. However, many researchers agree that moderate violations of assumptions have little or no effect on

---

[9]Many researchers take the square root transformations of scores that violate assumptions in the models. Positive skew is less problematic when the collection device is placed in the same specific area of the mouth (i.e., the left check) Harmon, A. G., Towe-Goodman, N. R., Fortunato, C. K., & Granger, D. A. 2008. Differences in saliva collection location and disparities in baseline and diurnal rhythms of alpha-amylase: A preliminary note of caution. ***Hormones and Behavior*** 54: 592–596. As explained in Chapter 4, when proctoring the experiment the PI made sure all salivettes were placed accordingly.

substantive conclusions (Cohen, 1988). Therefore, we proceed to test the homoscedasticity with the Box's M test.

Table 5-9 Levene's Test of Equality of Error Variances				
Model 1				
	F-statistic	Degrees of Freedom 1	Degrees of Freedom 2	P-value
Overload	1.377	3	39	.264
Conflict	.532	3	39	.663
Interruption Ambiguity	.471	3	39	.704
Message Ambiguity	2.331	3	39	.089
Model 2				
	F-statistic	Degrees of Freedom 1	Degrees of Freedom 2	P-value
Overload	2.196	2	30	.129
Interruption Ambiguity	1.257	2	30	.299
Model 3				
	F-statistic	Degrees of Freedom 1	Degrees of Freedom 2	P-value
Perceptual Strain*	2.214	7	79	.042
Alpha-Amylase	.822	7	79	.572
* Perceptual Strain holds up at the .01 level.				

Box's M also tests the homoscedasticity using an F distribution. In order to meet the assumption, the p-value should be greater than .05. Box's M is extremely sensitive to violations of the assumption of normality and unequal sample sizes. As such, typically researchers test at the p-value=.001 level (Garson, 2009). Since we deleted a few extreme outliers, we ended up having an unequal sample size per group, so we too set the test at the .001 level. Table 5-10 shows that the Box's M assumption was met for all three models.

Table 5-10 Box's Test of Equality of Covariance Matrices			
	Model 1	Model 2	Model 3
Box's M	55.885	4.872	42.128
F-statistic	1.504	.734	1.310
df1	30	6	24
df2	3988.201	22430.769	873.059
P-value	.038	.622	.146

Finally, we use the Bartlett's Test of Sphericity to test whether there are significant correlations among dependent variables within the MANOVA/MANCOVA models. The null hypothesis states that the intercorrelation matrix comes from a sample population in which the dependent variables are noncollinear. The residual correlations should approach zero when the residuals are random. Thus, to conclude that the test does not violate sphericity, the value should be non-significant. This assumption was violated for Model 1 and Model 3; however, because the model was comprised of random effects, moderate violations of assumptions have little or no effect on substantive conclusions (Cohen, 1988). Instead, random effect models assume normality, homogeneity of variances, and sphericity (Jackson & Brashers, 1994).

Table 5-11 Bartlett's Test of Sphericity			
	Model 1	Model 2	Model 3
Likelihood Ratio	.000	.460	.000
Approx. Chi-Square	74.870	1.223	421.469
Df	9	2	2
P-value	.000	.542	.000

5.4.2. Manipulation Checks

Having cleaned the data and checked for any violations of underlying assumptions, we next examined our manipulation checks for our treatments. While we had 8 groups comprised from 4 different independent variables, we were only interested in comparing 2 groups at a time (group A when the stressor was low, and group B when the stressor was high). To test for group differences we used independent samples t-tests (Student, 1908). We found that all of the manipulations to be successful except 1: demand variability (See Table 5-12).

For comparison 1, we tested the difference between a low and high quantitative demand, holding all else constant. A significant difference was found between the two groups (M_{low} = 2.7045 and M_{high} = 3.7250, t = 2.163, $p < .05$). To test the manipulation considering the interaction of timing control, we took the same mean from having a low quantitative demand and compared it to the mean of having a high quantitative demand and absent timing control. This manipulation was significant (comparison 2: M_{low} = 2.7045 and M_{high} = 4.00, t = 2.966, $p <.05$). Therefore, we conclude that our manipulation of quantitative demand was successful.

For comparison 3, we tested the difference between having a constant or a variable demand variability, holding all else constant. This manipulation was not significant (M_{low} = 2.9773 and M_{high} = 3.375, t = 1.167, $p <$ n.s.). Even though this manipulation was not significant, when we removed timing control and set demand to variable, the manipulation was successful (comparison 4: M_{low} =2.9773 and M_{high} = 3.5000, t = 1.947, $p < .05$), suggesting that timing control had to be absent for demand variability to be significant. Therefore, we conclude that our manipulation of demand variability was only successful during the absence of timing control. Results of demand variability when individuals experienced timing control should be interpreted with caution.

For comparison 5, we tested the difference between on and off task message profiles, holding all else constant. A significant difference was found between the two groups ($M_{on\text{-}task}$ = 2.8636 and $M_{off\text{-}task}$ = 3.9091, t = 4.196, $p < .05$). To test the manipulation considering the interaction of timing control, we took the same mean from the on-task message profile group and compared it directly to the mean of having an off-task message profile and absent timing control. This manipulation was significant (comparison 6: $M_{on\text{-}task}$ = 2.8636 and $M_{off\text{-}task}$ = 4.3409, t = 7.446, $p < .05$). Therefore, we conclude that our manipulation of message profile was successful.

Finally, we compared having timing control with not having timing control. We found a significant difference between the two groups (comparison 7: M_{yes} = 1.7273 and M_{no} = 3.4848, t = 3.926, $p < .05$). Therefore, we conclude that our manipulation of timing control was successful.

Table 5-12 Manipulation Checks

Comparison Factor	T-Statistic	Degrees of freedom (df)	Mean Group A	Mean Group B	P-value	Mean Difference	Std. Error Difference
Quantitative Demand	2.163	19	2.7045	3.7250	.044	1.02045	.47185
Quantitative Demand * Timing	2.966	20	2.7045	4.000	.008	1.29545	.43669

Control							
Demand Variability	1.167	21	2.9773	3.375	.256	.39773	.34076
Demand Variability * Timing Control	1.947	20	2.9773	3.500	.066	.52273	.26853
Message Profile	4.196	20	2.8636	3.9091	.000	1.04545	.24917
Message Profile * Timing Control	7.446	20	2.8636	4.3409	.000	1.47727	.19839
Timing Control	3.926	20	1.7273	3.4848	.001	1.75758	.44762
*All manipulations significant except demand variability							

5.4.3. Model Testing

The model testing is organized as follows. First, we test for the significance of the entire model by examining the Omnibus F. We closely examine control variables and exclude ones that do not explain any variance in our model. Next, we present the group means and standard deviations of the dependent variables that were significant in the Omnibus F-test. Then, we present the multivariate statistics to determine if each effect is significant on at least one of the dependent variable. If it is not significant, it is removed from further analysis. Finally, we conduct the univariate tests by providing the parameter estimates and conducting additional post hoc tests.

In testing the three models, the first step was to test whether the model is significant for each dependent variable by examining the Omnibus F. The null hypothesis states that the means of each dependent are equal across the categorical groups (i.e., the independent variables). Therefore, if the F-test is non-significant, we conclude that the treatments had an insignificant relationship with the dependent variable and that we have insufficient evidence to conclude that there are differences between the group means.

When conducting the Omnibus F-test, we also tested for significance of the control variables, which were initially run alongside the model and then removed if they did not lead to higher explanatory power. Control variables are discussed next, which is followed by the results of the Omnibus F-test.

5.4.3.1. Control Variables

As discussed in Chapter 4, we controlled for factors while testing our research models. For Model 1, we controlled for negative affect, gender, and age. The multivariate test of negative affect was significant at .1 level (Wilks' lambda = .775; F-statistic = 2.394). Age was significant at the .05 level (Wilks' lambda = .754; F-statistic = 2.693). Gender was non-significant (Wilks' lambda = .868, F-statistic = .1.253).

For Model 2, we controlled for negative affect, gender, and age. The multivariate test of negative affect was significant at .01 (Wilks' lambda = .578; F-statistic = 9.508). Gender was also significant at the .01 (Wilks' lambda =.661, F-statistic – 6.657). Age was insignificant (Wilks' lambda = .863; F-statistic = 2.059).

For Model 3, we controlled for caffeine, dairy, meal, alcohol usage, and age were initially included in the analysis as controls; however, the multivariate tests were insignificant, so they were removed from the final analysis. As discussed in Chapter 4, these variables were controlled for to isolate the variance explained on the objective dependent variables. However, in preparing subjects for participation, we attempted to eliminate these effects from occurring all together. Therefore, it was no surprise that they were non-significant controls in the model. Specifically, caffeine had a Wilks' lambda of

.919 (F-statistic = 1.875), dairy had a Wilks' lambda of .971 (F-statistic = .736), meal had a Wilks' lambda of .959 (F-statistic = 1.063), and alcohol had a Wilks' lambda of .930 (F-statistic = 1.875). After exploring further parameter tests, we confirmed that these control variables did not significantly affect the model and were removed to preserve power.

5.4.3.2. The Omnibus F-Test

After controlling for factors, all dependent variables in Model 1 and Model 2 were significant. For Model 3, blood pressure, both systolic and diastolic, and pulse were non-significant dependent variables in the model and therefore were removed from the analyses and left out of the discussion of results.

Table 5-13 Omnibus F-Test

Model 1						
Dependent Variable	Type III Sum of Squares	df	Mean Square	F-statistic	P-value	Partial Eta Squared
Overload*	450.324	7	64.332	68.390	.000	.930
Conflict*	420.506	7	60.072	85.575	.000	.943
Interruption Ambiguity*	273.266	7	39.038	85.113	.000	.943
Message Ambiguity*	318.371	7	45.482	104.762	.000	.953
Model 2						
Dependent Variable	Type III Sum of Squares	df	Mean Square	F-statistic	P-value	Partial Eta Squared
Overload*	426.339	6	71.056	111.795	.000	.961
Interruption Ambiguity*	211.772	6	35.295	78.648	.000	.946
Model 3						

Dependent Variable	Type III Sum of Squares	df	Mean Square	F-statistic	P-value	Partial Eta Squared
Perceptual Strain*	358.856	4	89.714	249.389	.000	.942
Alpha-Amylase*	32896.078	4	8224.020	5.095	.001	.250
* Values Significant at .01						

5.4.4. Hypotheses Testing

Before we present the hypotheses tests, Table 5-14 presents the group means and standard deviations of the dependent variables that were significant in the Omnibus F-test, therefore, excluding blood pressure and pulse. As defined in Chapter 4, perceptual strain was measured on a 5 point-Likert scale. The alpha-amylase averages presented below were computed by first subtracting the post-stress reading from the baseline reading (termed reactivity) and second dividing that number by the original baseline reading (Stroud et al., 2009).

Table 5-14 Group Means of Dependent Variables

Group Number	Quantitative Demand	Demand Variability	Message Profile	Timing Control	Perceptual Strain*		Alpha Amylase**	
					Mean	Std. Dev.	Mean	Std. Dev.
1	Low	Low	On-Task	Yes	2.09	.77	.11	13.24
2	High	Low	On-Task	Yes	1.98	.64	10.72	18.21
3	Low	High	On-Task	Yes	2.18	.94	-3.71	32.60
4	Low	Low	Off-Task	Yes	2.36	1.09	21.81	33.02
5	Low	Low	On-Task	No	2.63	.91	22.05	43.24
6	High	Low	On-Task	No	2.71	.71	37.21	83.81
7	Low	High	On-Task	No	2.38	.56	23.95	27.22
8	Low	Low	Off-Task	No	2.53	.78	8.33	20.25

* Measured on a 5 point scale (1= Strongly Disagree to 5=Strongly Agree)

** Alpha amylase scores were was computed by subtracting the post stress reading from the baseline reading and dividing that number by the baseline reading

5.4.4.1. Multivariate Tests

Next, using Wilks' lambda, we tested the multivariate significance of each effect on at least one of the dependent variables (See Table 5-15). This test focuses on the independent variables by examining the sum of squares, the sum of cross products, the covariances, and the group means. Wilks' lambda is the most rigorous multivariate test (Rencher, 2002), and is the only test we provide below. However, values from Pillai's Trace, Hotelling's Trace, and Roy's Largest Root were also evaluated and supported the results of the Wilks' lambda.

The Wilks' lambda value ranges from 0 to 1. The closer the value is to 0, the greater the effect contributes to the model. Model 1 and Model 2 both had a significant grouping variable. For Model 3, conflict and interruption ambiguity were insignificant. Significant results found after insignificant multivariate tests should be interpreted with caution.

Table 5-15 Multivariate Tests

	Model 1	Model 2	Model 3			
	Group Variable*	Group Variable**	Overload*	Conflict	Interruption Ambiguity	Message Ambiguity*
Wilks' Lambda	.277	.559	.856	.985	.938	.796
F-statistic	3.315	2.930	5.067	.444	1.989	7.680
Df1	16	6	2	2	2	2
Df2	101.454	52	60	60	60	60
P-Value	.000	.015	.009	.644	.146	.001
Partial Eta Squared	.275	.253	.165	.015	.062	.204

*Significant at the .01 level

**Significant at the .05 level

5.4.4.1.1. Test of Dependents

Next, we tested the effects of the independent variables on each dependent variable. In this sense, we move from multivariate tests (presented in the above section) to univariate tests (presented in this section). Each test presented in this chapter provides initial evidence supporting or not supporting our hypotheses - all the tests are highly related. Therefore, even though our conclusions about the hypotheses are at the end of section 5.4.4.3, the combination of univarate tests, the parameter estimates and post hoc tests will help determine the significance of our model.

The test of individual dependents is a between subjects test which provides an F-statistic to calculate the significance of the effect. The partial eta-square serves as a measure of the effect size, however, the sum of the partial eta squared values are not additive and do not sum up to amount for a combined level of variance accounted for by the independent variables (Tabachnick & Fidell, 1989).

Table 5-16 Test of Effects on Individual Dependents

Model 1							
Independent Variable	Dependent Variable	Type III Sum of Squares	df	Mean Square	F-statistic	P-value	Partial Eta Squared
Grouping Variable	Overload**	11.596	4	2.899	3.082	.028	.255
	Conflict**	10.216	4	2.554	3.638	.014	.288
	Interruption Ambiguity*	11.951	4	2.988	6.514	.000	.420
	Message Ambiguity*	8.400	4	2.100	4.837	.003	.350
Model 2							
Independent Variable	Dependent Variable	Type III Sum of Squares	df	Mean Square	F-statistic	P-value	Partial Eta Squared

Grouping Variable	Overload **	7.179	3	2.393	3.765	.022	.295
	Interruption Ambiguity	2.927	3	.976	2.174	.114	.195
Model 3							
Independent Variable	Dependent Variable	Type III Sum of Squares	df	Mean Square	F-statistic	P-value	Partial Eta Squared
Overload	Perceptual Strain*	2.538	1	2.538	7.056	.010	.104
	Alpha-Amylase***	5821.923	1	5821.923	3.607	.062	.056
Conflict	Perceptual Strain*	.316	1	.316	.877	.353	.014
	Alpha-Amylase	59.348	1	59.348	.037	.849	.001
Interruption Ambiguity	Perceptual Strain	.209	1	.209	.582	.448	.009
	Alpha-Amylase***	5413.243	1	5413.243	3.354	.072	.052
Message Ambiguity	Perceptual Strain*	2.625	1	2.625	7.296	.009	.107
	Alpha-Amylase*	12495.137	1	12495.137	7.741	.007	.113
* Values Significant at .01 **Values Significant at .05 ***Values Significant at .1							

5.4.4.1.2. Parameter Estimates

Next, we present the parameter estimates. In multivariate GLM analysis, beta coefficients are not interpreted the same as in OLS regression. Specifically, a unit change in an independent variable *does not* correspond to a change in the dependent variable as in OLS regression (Garson, 2009). This is because multivariate GLM uses a nonlinear link function. In GLM, parameter estimates are necessary to report, but are not simple to interpret as those found in OLS regression. To compare levels of a factor, one uses contrast analysis to compare level changes from one group to another, not the tests for the parameters (See Section 5.4.4.3).

However, for models 1 and models 2 (that use MANOVA) we discuss the parameter estimates in two steps prior to examining contrasts by first discussing their overall effect on perceptual stress (overload, conflict, message ambiguity, and interruption ambiguity), and then presenting the change in beta coefficients between the groups. Since Model 3 used MANCOVA and did not compare groups but instead used covariates, we present the overall effects with respect to strain. Therefore, while Model 1 and Model 2 require additional post-hoc analysis to make the final conclusions about the hypotheses, Model 3 makes the final conclusions about the hypotheses in this section.

5.4.4.1.2.1. Model 1: Parameter Estimates

For Model 1, the table below suggests low strain significantly affected overload (t-statistic = 1.970, p-value < .1), conflict (t-statistic = 2.215, p-value < .05), interruption ambiguity (t-statistic = 4.144, p-value < .01), and message ambiguity (t-statistic = 3.104, p-value < .05). Having a high quantitative demand also significantly affected overload (t-statistic = 2.605, p-value < .05), conflict (t-statistic = 2.661, p-value < .05), interruption ambiguity (t-statistic = 4.339, p-value < .01), and message ambiguity (t-statistic = 3.197, p-value < .01). Having a high demand variability also significantly affected overload (t-statistic = 2.108, p-value < .05), conflict (t-statistic = 2.396, p-value < .05), interruption ambiguity (t-statistic = 3.989, p-value < .01), and message ambiguity (t-statistic = 2.836, p-value < .01). Finally, having an off-task message profile also significantly affected overload (t-statistic = 2.220, p-value < .05), conflict (t-statistic = 2.854, p-value < .01), interruption ambiguity (t-statistic = 4.602, p-value < .01), and message ambiguity (t-statistic = 3.542, p-value < .01).

Second, we compare the beta coefficients of the groups to see the change in beta by moving from one group to another. If the beta coefficient is higher than the coefficient in the low strain group, we can make casual assertions that the model was successful.

However, as discussed above, the post hoc tests will formally test for group differences in the next section.

When the group was 1 (termed low strain) subjects had a beta coefficient of 3.49 for overload, 3.389 for conflict, 5.126 for interruption ambiguity, and 3.736 for message ambiguity. When we changed the effect of quantitative demand to high, their level of overload went up to 4.461($\Delta\beta$ = .972), their level of conflict went up to 3.936 ($\Delta\beta$ = .547), their level of interruption ambiguity went up to 5.187 ($\Delta\beta$ = .0617). When quantitative demand was high, message ambiguity went down to 3.718 ($\Delta\beta$ = .018). Since this relationship was not hypothesized and the change was negligible between the two groups, this finding was not surprising. When we changed the effect of demand variability to high, their level of overload went up to 3.652 ($\Delta\beta$ = .163), their level of conflict went up to 3.587 ($\Delta\beta$ = .198). Both interruption ambiguity and message ambiguity went down to 4.826 ($\Delta\beta$ = .3) and 3.339 ($\Delta\beta$ = .397). Since the manipulation for demand variability was unsuccessful during the presence of timing control, this finding was not surprising. When we changed the effect of message profile to off-task, their level of overload went up to 3.975 ($\Delta\beta$ = .486), their level of conflict went up to 4.413 ($\Delta\beta$ = 1.024), their level of interruption ambiguity went up to 5.752 ($\Delta\beta$ = .626), and their level of message ambiguity went up to 4.307($\Delta\beta$ = .571).

5.4.4.1.2.2. Model 2: Parameter Estimates

For Model 2, the table below suggests low strain, the interaction of quantitative demand with no timing control, and the interaction of demand variability with no timing control did not significantly affect overload (t-statistic = .891, p-value = n.s.; t-statistic = 1.426, p-value = n.s.; t-statistic = 1.463, p-value = n.s.). However, all three significantly led to interruption ambiguity. Specifically, low strain led to interruption ambiguity (t-statistic = 2.471, p-value < .05). The quantitative demand interaction significantly led to interruption ambiguity (t-statistic = 2.492, p-value < .05), and the demand variability interaction significantly led to interruption ambiguity (t-statistic = 2.550, p-value < .05).

Second, we compare the beta coefficients of the groups to see the change in beta by moving from one group to another. If the beta coefficient is higher than the coefficient in the low strain group, we can make casual assertions that the model was successful. However, as discussed above, the post hoc tests will formally test for group differences in the next section. The low strained subjects had a beta coefficient of 1.490 for overload and 3.474 for interruption ambiguity. When we added the interaction of quantitative demand and timing control, their level of overload went up to 2.418 ($\Delta\beta = .928$) and their level of interruption ambiguity went up to 3.550 ($\Delta\beta = .076$). When we compared the low strain group to the interaction of demand variability and timing control, their overload went up to 2.492 ($\Delta\beta = 1.002$) and their level of interruption ambiguity went up to 3.650 ($\Delta\beta = .076$).

5.4.4.1.2.3. Model 3: Parameter Estimates

Model 3 used covariates as predictors as opposed to categorical variables. Therefore, instead of examining post hoc tests, the parameter estimates test the overall significance of the hypotheses for each dependent variable. Thus, this section tests hypotheses 4a, 4b, and 4c, that overload, conflict, and ambiguity lead to strain (alpha-amylase and perceptual strain).

Hypothesis 4a stated that overload positively lead to strain. Our results suggest that overload did positively affect strain. Specifically, both perceptual strain and alpha-amylase measures were significantly higher when subjects were overloaded (perceptual strain: β=.295, t-statistic = 2.656, p-value <.01; alpha-amylase: β=14.149, t-statistic = 1.899, p-value <.1).

Hypothesis 4b stated that perceptual ambiguity positively lead to strain. We found partial support for this hypothesis. Message ambiguity significantly lead to both alpha-amylase and strain (perceptual strain: β=.400, t-statistic = 2.701, p-value <.01; alpha-amylase: β=27.614, t-statistic = 2.782, p-value <.01). Interruption ambiguity only significantly contributed to alpha-amylase (perceptual strain: β=-.089, t-statistic = .763, p-value < n.s.; alpha-amylase: β=14.335, t-statistic = 1.831, p-value <.1).

Hypothesis 4c stated that perceptual conflict positively lead to strain. We found no support for this hypothesis (perceptual strain: β=.120, t-statistic = .937, p-value <n.s.; alpha-amylase: β=1.648, t-statistic = .192, p-value =n.s.).

Table 5-17 Parameter Estimates

Model 1								
Dependent Variable	Parameter	B	Std. Error	T-statistic	P-value	95% Confidence Interval		Partial Eta Squared
						Lower Bound	Upper Bound	
Overload	[Low Strain]***	3.489	1.771	1.970	.057	-.104	7.081	.097
	[Quantitative Demand=high]**	4.461	1.712	2.605	.013	.988	7.933	.159
	[Demand Variability=high]**	3.652	1.733	2.108	.042	.138	7.167	.110
	[Message Profile=off-task]**	3.975	1.790	2.220	.033	.344	7.605	.120
	Negative Affect*	.960	.320	3.002	.005	.311	1.608	.200

	Age	-.108	.065	-1.651	.108	-.240	.025	.070
	Gender	.084	.329	.256	.799	-.582	.751	.002
Conflict	[Low Strain]**	3.389	1.530	2.215	.033	.286	6.493	.120
	[Quantitative Demand=high]**	3.936	1.479	2.661	.012	.936	6.936	.164
	[Demand Variability=high]**	3.587	1.497	2.396	.022	.551	6.623	.138
	[Message Profile=off-task]*	4.413	1.546	2.854	.007	1.277	7.549	.184
	Negative Affect*	.776	.276	2.812	.008	.216	1.336	.180
	Age***	-.102	.056	-1.811	.079	-.216	.012	.083
	Gender	.176	.284	.618	.540	-.400	.751	.011
Interruption Ambiguity	[Low Strain]*	5.126	1.237	4.144	.000	2.617	7.634	.323
	[Quantitative Demand=high]*	5.187	1.196	4.339	.000	2.763	7.612	.343
	[Demand Variability=high]*	4.826	1.210	3.989	.000	2.372	7.280	.306
	[Message Profile=off-task]*	5.752	1.250	4.602	.000	3.218	8.287	.370
	Negative Affect	.179	.223	.801	.428	-.274	.631	.018
	Age*	-.133	.046	-2.922	.006	-.225	-.041	.192
	Gender	-.137	.229	-.597	.554	-.602	.328	.010
Message Ambiguity	[Low Strain]*	3.736	1.203	3.104	.004	1.295	6.176	.211
	[Quantitative Demand=high]*	3.718	1.163	3.197	.003	1.359	6.077	.221
	[Demand Variability=high]*	3.339	1.177	2.836	.007	.951	5.726	.183
	[Message Profile=off-task]*	4.307	1.216	3.542	.001	1.841	6.773	.258
	Negative Affect*	.586	.217	2.700	.010	.146	1.027	.168
	Age*	-.114	.044	-2.574	.014	-.204	-.024	.155
	Gender	.317	.223	1.420	.164	-.136	.770	.053
Model 2								
Dependent Variable	Parameter	B	Std. Error	T-statistic	P-value	95% Confidence Interval		Partial Eta Squared
						Lower Bound	Upper Bound	
Overload	[Low Strain]	1.490	1.673	.891	.381	-1.943	4.924	.029
	[Quantitative Demand=High] * [Timing Control=NO]	2.418	1.695	1.426	.165	-1.061	5.897	.070
	Demand Variability=High] * [Timing	2.492	1.703	1.463	.155	-1.003	5.987	.073

Dependent Variable	Parameter	B	Std. Error	T-statistic	P-value	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound	Partial Eta Squared
	Control=No]							
	Negative Affect*	.798	.241	3.311	.003	.303	1.292	.289
	Age	-.066	.075	-.870	.392	-.220	.089	.027
	Gender*	.976	.293	3.335	.002	.375	1.576	.292
Interruption Ambiguity	[Low Strain]**	3.474	1.406	2.471	.020	.589	6.359	.184
	[Quantitative Demand=High] * [Timing Control=NO]**	3.550	1.425	2.492	.019	.627	6.473	.187
	Demand Variability=High] * [Timing Control=No]**	3.650	1.431	2.550	.017	.714	6.587	.194
	Negative Affect**	.508	.202	2.510	.018	.093	.923	.189
	Age***	-.111	.063	-1.747	.092	-.241	.019	.102
	Gender	.295	.246	1.199	.241	-.210	.799	.051
Model 3								
Dependent Variable	Parameter	B	Std. Error	T-statistic	P-value	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound	Partial Eta Squared
Strain	Overload *	.295	.111	2.656	.010	.073	.518	.104
	Conflict	.120	.128	.937	.353	-.136	.377	.014
	Interruption Ambiguity	-.089	.117	-.763	.448	-.323	.145	.009
	Message Ambiguity*	.400	.148	2.701	.009	.104	.696	.107
Alpha-Amylase	Overload ***	14.149	7.450	1.899	.062	-.749	29.046	.056
	Conflict	1.648	8.594	.192	.849	-15.537	18.832	.001
	Interruption Ambiguity***	14.355	7.839	1.831	.072	-1.320	30.029	.052
	Message Ambiguity*	-27.614	9.925	-2.782	.007	-47.461	-7.768	.113

* Values Significant at .01

**Values Significant at .05

***Values Significant at .1

5.4.4.3. Post-hoc tests

Post-hoc tests examine the differences between the levels of the independent categorical variables with respect to the dependent variables (Fisher, 1942). These tests are univariate tests as opposed to multivariate tests, and thus were only calculated after significance was determined by the multivariate F tests. To test for differences, we use the least significant difference (LSD) test for multiple comparisons (See Table 5-18). The null hypotheses of the LSD tests state that a specific group differs from another group on a single dependent variable.

Hypothesis 1 stated that quantitative demand associated with ICT – enabled interruptions positively affects perceptual overload. As shown below, when quantitative demand was high, their averaged feelings of overload were .972 higher than when quantitative demand was low (μ_{low}=2.8864, μ_{high}=3.6250, p-value <.01). All dependent variables were measured on a 5-point Likert scale, so the finding suggests that when overload was high, subjects went up an entire point on the Likert sale. Therefore, based on the analysis, we conclude that our hypothesis is supported and quantitative demand does positively affect overload.

Hypotheses 2a and 2b stated that demand variability associated with ICT – enabled interruptions positively affects perceptual overload and interruption ambiguity. We found insufficient evidence to confirm this assertion. Specifically, overload was .164 higher when demand was variable (μ_{low}=2.8864, μ_{high}=2.014, p-value=n.s.) and interruption ambiguity was .299 lower when demand was variable (μ_{low}=2.4242, μ_{high}=2.1667, p-value=n.s.), Therefore, we rejected the null hypotheses and concluded that a variable demand did not significantly lead overload or interruption ambiguity.

Hypotheses 3a and 3b stated that message profile affects perceptual message ambiguity and perceptual conflict. We found evidence to support both of these hypotheses. Specifically, when messages were off-task, subjects felt .572 more ambiguity in the messages (μ_{low}=2.7727, μ_{high}=3.1591, p-value <.1). Similarly, the averaged conflict was 1.023 higher than when messages were off-task (μ_{low}=2.7576, μ_{high}=3.6061, p-value <.01). Based on these findings, we fail to reject the null hypotheses and conclude that message profile positively affects message ambiguity and conflict.

Hypotheses 4a, 4b, and 4c testes whether overload, ambiguity, and conflict positively affected strain. However, these variables were entered as covariates, thus, comparative t-tests are inappropriate.

Hypotheses 5a, 5b, and 5c concern the interaction of timing control with demand stressors: Hypothesis 5a states that timing control over the ICT negatively moderates the relationship between quantitative demand and perceptual overload. When subjects were exposed to a high quantitative demand, stress responses were .928 higher when timing control was absent as opposed to having timing control (μ_{low}=2.8864, μ_{high}=3.7727, p-value <.05). Therefore, we conclude that timing control moderates the relationship between quantitative demand and overload. Hypothesis 5b states that timing control over the ICT negatively moderates the relationship between demand variability and perceptual overload. When subjects were exposed to a high demand variability, stress responses were 1.002 higher when timing control was absent as opposed to having timing control (μ_{low}=2.8864, μ_{high}=3.7955, p-value <.01). Therefore, we conclude that timing control moderates the relationship between demand variability and overload. Hypothesis 5c states that timing control over the ICT negatively moderates the relationship between demand variability and interruption ambiguity. We did not find support for hypothesis 5c (μ_{low}=2.4242, μ_{high}=3.5152, p-value = n.s.).Therefore, our analysis supported hypothesis 5a and hypothesis 5b while providing no evidence to support hypothesis 5c.

Table 5-18 Least Significant Differences (LSD) Pairwise Comparisons

Dependent Variable	(I) Low	(J) High	Mean Difference (I-J)	Std. Error	P-Value
Model 1 Quantitative Demand					
Overload**	2.8864	3.6250	-.972	.434	.031
Conflict	2.7576	3.1000	-.547	.375	.153
Interruption Ambiguity	2.4242	2.4667	-.062	.303	.840
Message Ambiguity	2.7727	2.5750	.017	.295	.954
Demand Variability					
Overload	2.8864	3.0417	-.164	.416	.697
Conflict	2.7576	2.9167	-.198	.360	.586
Interruption Ambiguity	2.4242	2.1667	.299	.291	.310
Message Ambiguity	2.7727	2.2917	.397	.283	.169
Message Profile					
Overload	2.8864	3.2500	-.486	.442	.279
Conflict**	2.7576	3.6061	-1.023	.382	.011
Interruption Ambiguity**	2.4242	2.8485	-.627	.309	.050
Message Ambiguity***	2.7727	3.1591	-.572	.300	.065
Model 2 Quantitative Demand * Timing Control					
Overload**	2.8864	3.7727	-.928	.343	.012
Interruption Ambiguity	2.4242	2.4848	-.076	.288	.794
Demand Variability * Timing Control					
Overload*	2.8864	3.7955	-1.002	.349	.008
Interruption Ambiguity	2.4242	3.5152	-.176	.293	.553

5.4.5. Summary of Experiment

Table 5-19 provides a summary of the results found.

Table 5-19 Summary of Results			
Hypothesis		Supported?	
H1	Quantitative demand associated with ICT – enabled interruptions positively affects perceptual overload.	Yes	
H2a	Demand variability associated with ICT – enabled interruptions positively affects perceptual overload.	No	
H2b	Demand variability associated with ICT – enabled interruptions positively affects perceptual interruption ambiguity.	No	
H 3a	Message profile affects perceptual message ambiguity.	Yes	
H3b	Message profile affects perceptual conflict.	Yes	
H4a	Perceptual overload positively affects strain.	Yes	
		Strain	Yes
		Alpha-Amylase	Yes
H 4b	Perceptual interruption ambiguity positively affects strain.	Partial	
		Perceptual Strain	No
		Alpha-Amylase	Yes
H4c	Perceptual message ambiguity positively affects strain.	Yes	
		Perceptual Strain	Yes
		Alpha-Amylase	Yes
H4d	Perceptual conflict positively affects strain.	No	
		Perceptual Strain	No
		Alpha-Amylase	No
H5a	Timing control over the ICT negatively moderates the relationship between quantitative demand and perceptual overload.	Yes	
H5b	Timing control over the ICT negatively moderates the relationship between demand variability and perceptual overload.	Yes	

H5c	Timing control over the ICT negatively moderates the relationship between demand variability and perceptual interruption ambiguity.	No

5.5. Experiment 2

For Experiment 2, we also use multivariate analysis (both MANOVA and MANCOVA). As discussed in Experiment 1, the purpose of a MANOVA is to compare the groups formed by categorical independent variables with a set of dependent variables. MANCOVA relaxes the categorical requirements of the independent variables and allows for the processing of any covariates. To test our model presented in Chapter 3 and designed in Chapter 4, we ran 2 different MANOVA analyses: Model 1 and Model 2 (See Figure 5-5 and Figure 5-6). Using MANOVA, Model 1 tested the overarching hypothesis of coping on strain. Using MANCOVA, Model 2 tested the interaction of resource control and method control on stress to strain.

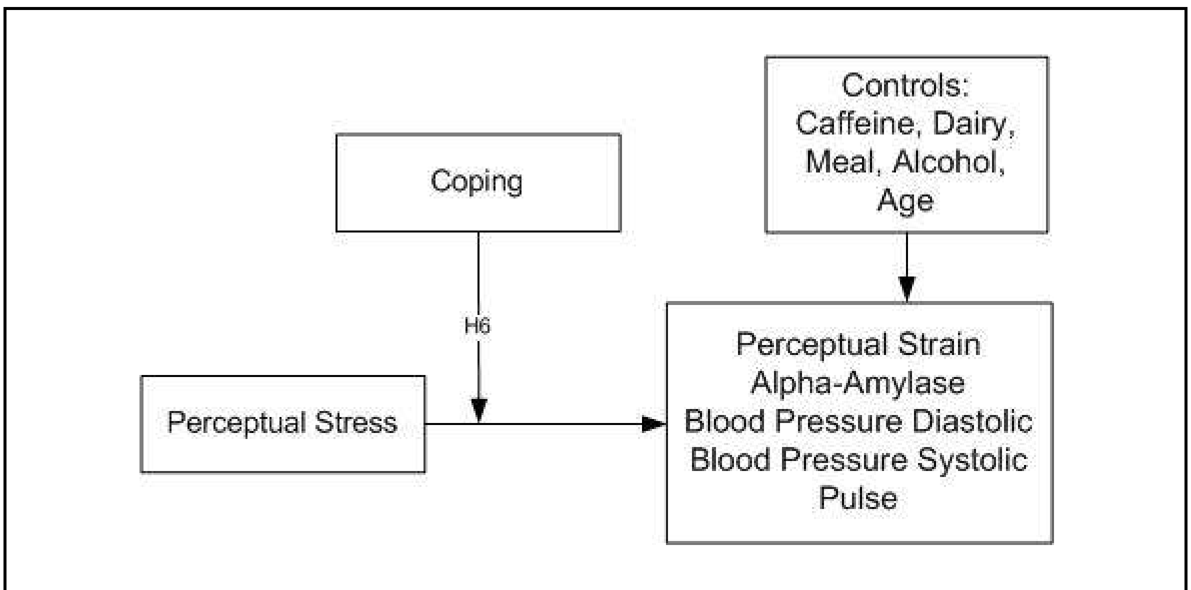


Figure 5-5 Experiment 2 Model 1

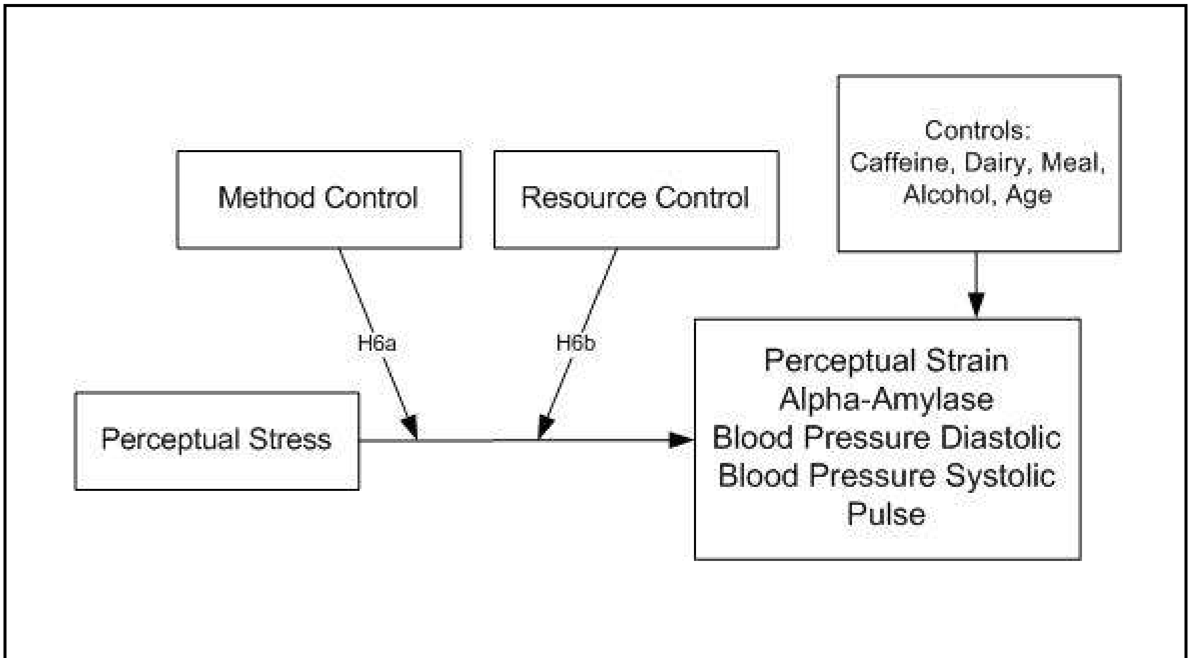


Figure 5-6 Experiment 2 Model 2

5.5.1. Assumptions

To ensure the validity of the multivariate statistics, we test all the underlying assumptions. The first assumption is that the dependent variables are continuous and interval level. Each model focuses on objective and perceptual strain measures, which in fact are continuous variables. Therefore, we conclude that we meet this assumption.

The second assumption of MANOVA suggests that the independent variables must be categorical. For Model 1, the group coping variable was manipulated in the experiment as categorical (coping /no coping), thus meeting the assumption. For Model 2, the dimensions of perceptual stress (overload, ambiguity, and conflict) were measured on a Likert scale and are considered continuous variables. Instead of transforming these variables into categories, we tested this model as a MANCOVA, as opposed to a MANOVA. This allowed us to relax that assumption for general MANOVAs. All the other assumptions are identical between MANOVAs and MANCOVAs. We conclude that the data does not violate this assumption.

The third assumption states that the distribution must be normal. Table 5-20 presents the normality statistics after we deleted 9 outliers that were 3 standard deviations above the mean. After we deleted these outliers, the coping group had a sample size of 39, and the non-coping group had a sample size of 40, giving us a total sample size of 79 for this study.

Because we were dealing with objective stress variables, cases needed to carefully examine the data for violations in normality. Specifically, we must check the data for positive skew in the alpha-amylase values before entering them as the dependent variable in the model. For example, coping had a standard error of .378, which multiplied by 2 gives us a value of .756. This value is greater than the skewness value of .505 so we conclude that the data is normal. No coping was slightly positively skewed. .374 multiplied by 2 gave us a value of .748 which is slightly lower than 1.082.

We use the same numerical formula as skewness to evaluate kurtosis: by multiplying the standard error by 2 and seeing if it is greater than the absolute value of the kurtosis score. We found that coping displayed moderate signs of kurtosis (.741*2 =

1.482, which is less than 2.513). No coping appeared to be normal (.733*2 =1.466, which is greater than the score of 1.115). Therefore, we conclude that the data is normal[10].

Table 5-20 Normality Results

Group Number	Skewness		Kurtosis		Shapiro- Wilk		Outliers Deleted
	Statistic	Std. Error	Statistic	Std. Error	Statistic	P-value	
Coping	.505	.378	2.513	.741	.925	.012	Case 706 Case 718 Case 724 Case 725 Case 814
No Coping	1.082	.374	1.115	.733	.919	.007	Case 712 Case 723 Case 740 Case 826
Final Sample Size: 79							

The next assumption is Homoscedasticity (homogeneity of variances and covariance). This suggests that the error variance of each interval dependent should be similar. To test this assumption we use the Levene's Test of Equality of Variances. Typically, each statistic should be non-significant in order to meet the assumption. Table 5-21 suggests that the majority of the model did not violate the assumption. In Model 1, blood pressure diastolic was significant at the .05 level. In Model 2, perceptual strain was significant at the .001 level. Many researchers agree that moderate violations of assumptions have little or no effect on substantive conclusions (Cohen, 1988). Therefore,

---

[10]Many researchers take the square root transformations of scores that violate assumptions in the models. Positive skew is less problematic when the collection device is placed in the same specific area of the mouth (i.e., the left check) Harmon, A. G., Towe-Goodman, N. R., Fortunato, C. K., & Granger, D. A. 2008. Differences in saliva collection location and disparities in baseline and diurnal rhythms of alpha-amylase: A preliminary note of caution. ***Hormones and Behavior*** 54: 592–596.. As explained in Chapter 4, when proctoring the experiment the PI made sure all salivettes were placed accordingly.

before concluding that the violation will sway our results, we proceed to test the homoscedasticity with the Box's M test.

Table 5-21 Levene's Test of Equality of Error Variances				
Model 1	F-statistic	df1	df2	P-value
Coping*Perceptual Stress				
Alpha-Amylase	.821	1	74	.368
Perceptual Strain	.672	1	74	.415
Blood Pressure Diastolic*	4.616	1	74	.035
Pulse	.872	1	74	.353
Model 2				
Method Control*Perceptual Stress Resource Control*Perceptual Stress				
	F-statistic	df1	df2	P-value
Alpha-Amylase	.670	7	69	.697
Perceptual Strain*	3.811	7	69	.001
* Levene's test was significant so the data failed the assumption of equal group error variances.				

Box's M also tests the homoscedasticity using an F distribution. In order to meet the assumption, the F should be greater than .05. However, Box's M is extremely sensitive to violations of the assumption of normality and unequal sample sizes. Therefore, typically researchers test at the p=.001 level (Garson, 2009). Since we deleted a few extreme outliers, we ended up having an unequal sample size per group, so we set the test at the .001 level. Table 5-22 shows that the Box's M assumption was met for all three models.

Table 5-22 Box's Test of Equality of Covariance Matrices		
	Model 1	Model 2
Box's M	16.382	58.203

F-statistic	1.542	1.203
Df1	10	36
Df2	26008.107	984.412
P-value	.117	.193

Finally, we use the Bartlett's Test of Sphericity to test whether there are significant correlations among dependent variables after controlling within the multivariate models. The null hypothesis states that the intercorrelation matrix comes from a sample population in which the variables are noncollinear. The residual correlations should approach zero when the residuals are random. Thus, to conclude that the test does not violate sphericity, the value should be non-significant. This assumption was violated for Model 1 and Model 2; however, because the model was comprised of random effects, moderate violations of assumptions have little or no effect on substantive conclusions (Cohen, 1988). Instead, random effect models assume normality, homogeneity of variances, and sphericity (Jackson et al., 1994).

Table 5-23 Bartlett's Test of Sphericity

	Model 1	Model 2
Likelihood Ratio	.000	.000
Approximate Chi-Square	620.636	558.973
Df	9	2
P-value	.000	.000

5.5.2. Manipulation Checks

Now that we have cleaned the data and checked for any violations in the underlying assumptions, we check the manipulations of the independent variables. For Model 1, we had 2 groups (coping and non-coping). For Model 2, we test the interaction of the two within variables (resource control and method control) with perceptual stress. It is also important to note that, instead of testing the interaction of each perceptual stress dimension, we averaged the dimensions into a single value (Perceptual Stress). This was possible because the dimensions did not violate any assumptions and had a Cronbach's alpha of .80.

To test the significance of the manipulations we used independent samples t-tests (Student, 1908). We found that both of the manipulations held up (See Table 5-24). Specifically, for comparison 1, we tested the difference between a low and high resource control, holding all else constant. A significant difference was found between the two groups (M_{low} = 1.9167 and M_{high} = 4.4701, t = 13.764, $p < .001$). For comparison 2, we tested the manipulation of method control. We also found a significant difference between the two groups (M_{low} = 2.7500 and M_{high} = 4.5299, t = 8.237, $p < .001$). Thus, we conclude that the manipulations were successful.

Table 5-24 Manipulation Checks

Group Category for Comparison	Mean for Group with No Coping	Mean for Coping Group	Mean Difference	P-value	T-statistic
Resource Control*	1.9167	4.4701	2.55342	.000	13.764
Method Control*	2.7500	4.5299	1.77991	.000	8.237

*Manipulation Significant at .01

5.5.3. Model Testing

The model testing is organized as follows. First, we test for the significance of the entire model by examining the Omnibus F. We closely examine control variables and exclude ones that do not explain any variance in our model. Next, we present the group means and standard deviations of the dependent variables that were significant in the Omnibus F-test. Then, we present the multivariate statistics to determine if each effect is significant on at least one of the dependent variable. If it is not significant, it is removed from further analysis. Finally, we conduct the univariate tests by providing the parameter estimates and conducting additional post hoc tests.

In testing the models, the first step was to test whether the model was significant for each dependent variable (See Table 5-25). When conducting the Omnibus F-test, we also test for significance of the control variables, which were initially run alongside the model and then removed if they did not lead to higher explanatory power. The null hypothesis of the Omnibus F states that the means of each dependent are equal across the categorical groups (i.e., the independent variables). Control variables are discussed next, which is followed by the results of the Omnibus F-test.

5.5.3.1. Control Variables

In testing the models, we also controlled for factors that would add explanatory power to our model. In regards to Model 1, caffeine, dairy, meal, alcohol usage, and age were initially included in the analysis as controls, however, the multivariate tests were insignificant, so they were removed from the final analysis. As discussed in Chapter 4, these variables were controlled for to isolate the variance explained on the objective dependent variables. However, in preparing subjects for to participation, we attempted to eliminate these effects from occurring all together. Therefore, it was no surprise that they were non-significant controls in the model. Specifically, caffeine had a Wilks' lambda of .871 (p-value=n.s), dairy had a Wilks' lambda of .937 (p-value=n.s), meal had a Wilks' lambda of .949 (p-value = n.s.), alcohol had a Wilks' lambda of .955 (p-value=n.s.) and age had a Wilks' lambda value of .960 (p-value<n.s.)[11]. After exploring further parameter tests, we confirmed that they did not significantly affect the model.

For Model 2, caffeine, dairy, meal, alcohol usage and age were also initially included in the analysis as controls. However, the initial multivariate tests were insignificant, so they were removed from the final analysis. Specifically, caffeine had a Wilks' lambda of .890 (p-value=n.s), dairy had a Wilks' lambda of .930 (p-value=n.s), meal had a Wilks' lambda of .871(p-value = n.s.), alcohol had a Wilks' lambda of .979 (p-value=n.s.) and age had a Wilks' lambda value of .888 (p-value<n.s.). After exploring further parameter tests, we confirmed that they did not significantly affect the model and thus were removed.

5.5.3.2. The Omnibus F-test

For Model 1, blood pressure systolic was the only non-significant predictor in the model and therefore removed from further analysis. For Model 2, blood pressure (systolic and diastolic) and pulse were non-significant predictors and therefore removed from the model. Since the model test was insignificant, there was no need to present and discuss results. Any significant results found after an insignificant Omnibus F-test would be due to error[12].

---

[11] Negative Affect was also included initially as a control variable. However, it was determined that while the multivariate test was significant (p-value <.05), it was only related to perceptions of strain (p-value <.01). We removed this variable from the analysis because it did not significantly help isolate the relationships between perceptions of stress and objective strain. Model 2 had the same issue as Model 1.

[12] We carefully examined the results from the dependent variables prior to removing them and concluded that the results were in fact non-significant throughout the analysis.

Table 5-25 Omnibus F-Test						
Model 1: Overall Coping						
Dependent Variable	Type III Sum of Squares	df	Mean Square	F-statistic	P-value	Partial Eta Squared
Alpha-Amylase*	16789.230	2	8394.615	7.551	.001	.169
Perceptual Strain*	523.285	2	261.642	367.008	.000	.908
Blood Pressure Diastolic*	649.452	2	324.726	5.725	.005	.134
Blood Pressure Systolic	23.509	2	11.755	.316	.730	.008
Pulse**	309.580	2	154.790	3.859	.025	.094
Model 2: Resource and Method Control						
Dependent Variable	Type III Sum of Squares	df	Mean Square	F-statistic	P-value	Partial Eta Squared
Alpha-Amylase*	23851.254	7	3407.322	3.126	.006	.241
Perceptual Strain*	530.137	7	75.734	113.842	.000	.920
Blood Pressure Diastolic	653.430	7	93.347	1.536	.170	.135
Blood Pressure Systolic	313.457	7	44.780	1.256	.285	.113
Pulse**	485.835	7	69.405	1.715	.120	.148
*Significant at .01 **Significant at .05						

5.5.4. Hypotheses Testing

Before we present the hypotheses tests, Table 5-26 presents the group means and standard deviations of the dependent variables that were significant in the Omnibus F test. As defined in Chapter 4, perceptual strain was measured on a 5 point Likert scale.

The alpha-amylase averages presented below were computed by first subtracting the post-stress reading from the baseline reading (termed reactivity) and second dividing that number by the original baseline reading (Stroud et al., 2009). Blood pressure was handled the same way (by dividing reactivity by the baseline reading).

Table 5-26 Dependent Variable Means					
Group Number	Group Category	Stress		Alpha-Amylase	
		Mean	Standard Deviation	Mean	Standard Deviation
151	Coping	2.58	.83	6.08	32.81
150	No Coping	2.63	.86	18.75	40.43
Group Number	Group Category	Pulse		Blood Pressure – Diastolic	
		Mean	Standard Deviation	Mean	Standard Deviation
151	Coping	-2.3846	6.79634	-3.7949	6.18223
150	No Coping	-1.1579	6.19296	-1.0769	8.82695

5.5.4.1. Multivariate Tests

Next, we tested the significance of each independent variable on at least one dependent variable. This is termed the multivariate test, and is measured using Wilks lambda (See Table 5-27). This test focuses on the independent variables by examining the sum of squares, the sum of cross products, the covariances, and the group means. Wilks' lambda is the most rigorous multivariate test (Rencher, 2002), and is the only test present below. However, values from Pillai's Trace, Hotelling's Trace, and Roy's Largest Root were also evaluated and supported the results of the Wilks' lambda. The Wilks' lambda value ranges from 0 to 1. The closer the value is to 0, the greater the effect contributes to the model. For Model 1, coping significantly affected at least one dependent variable. For Model 2, the interaction of method control with stress was significant, so the interaction does affect at least one dependent variable. The interaction of resource control with stress was insignificant. We conclude that both models are significant on at least one dependent variable.

Table 5-27 Multivariate Tests						
Model 1						
	Wilk's Lambda	F-statistic	Df	Error df	P-value	Partial Eta Squared
Coping*	.082	44.183	8	142	.000	.713
Model 2						
Resource Control * Perceptual Stress	.945	2.201	2	76	.118	.055
Method Control * Perceptual Stress*	.672	18.527	2	76	.000	.328
* Significant at .01						

5.5.4.1.1. Test of Dependents

Next, we tested the effects of the independent variables on each dependent variable. In this sense, we move from multivariate tests (presented in the above section) to univariate tests (presented in this section). Each test presented in this Chapter provides initial evidence supporting or not supporting our hypotheses - all the tests are highly related. Therefore, even though our conclusions about the hypotheses are at the end of section 5.5.4.3, the combination of univarate tests, the parameter estimates and post hoc tests will help determine the significance of our model.

The test of individual dependents is a between subjects test which provides an F-statistic to calculate the significance of the effect (see Table 5-28). The partial eta-square serves as a measure of the effect size, however, the sum of the partial eta squared values are not additive and do not sum up to amount for a combined level of variance accounted for by the independent variables (Tabachnick et al., 1989). The table below suggests that all tests of the individual dependents are significant except 1 test, the relationship between the interaction of resource control and perceptual stress and perceptual strain.

Table 5-28 Test of Effects on Individual Dependents

Dependent Variable	Type III Sum of Squares	df	Mean Square	F-statistic	P-value	Partial Eta Squared
Model 1						
Alpha-Amylase*	16789.230	2	8394.615	7.551	.001	.169
Perceptual Strain*	523.285	2	261.642	367.008	.000	.908
Blood Pressure Diastolic*	649.452	2	324.726	5.725	.005	.134
Pulse*	309.580	2	154.790	3.859	.025	.094
Model 2						
Resource Control*Perceptual Stress						
Alpha-Amylase***	4521.260	1	4521.260	3.504	.065	.044
Perceptual Strain	.383	1	.383	.295	.588	.004
Method Control* Perceptual Stress						
Alpha-Amylase*	10008.696	1	10008.696	7.757	.007	.092
Perceptual Strain*	45.610	1	45.610	35.224	.000	.314

*Significant at .01

**Significant at .05

***Significant at .1

5.4.4.1.2. Parameter Estimates

Next, we present the parameter estimates. In multivariate GLM analysis, beta coefficients are not interpreted the same as in OLS regression. Specifically, a unit change in an independent variable *does not* correspond to a change in the dependent variable as in OLS regression (Garson, 2009). Parameter estimates are a necessary step in GLM analysis, but do not lend themselves to the sorts of simple interpretation found for parameter estimates in OLS regression. Therefore, to compare levels of a factor, one compares group differences in contrast analysis, not the tests for the parameters.

For Model 1 (that used MANOVA) we discussed the parameter estimates in two steps prior to comparing groups by first discussing their overall effect on strain (alpha-amylase and perceptual strain), and then presenting the change in beta coefficients between the groups. Since Model 2 used MANCOVA and did not compare groups, but instead used covariates, we presented the overall effects with respect to strain. Therefore, while Model 1 requires additional post-hoc analysis to make the final conclusions about the hypotheses, we made the final conclusions about the hypotheses examined in Model 2 in this section.

5.4.4.1.2.1. Model 1: Parameter Estimates

For Model 1, the table below suggests that not coping was significantly related to alpha-amylase and perceptual strain, but was insignificantly related to blood pressure and pulse rate (alpha-amylase: t-statistic = 3.716, p-value < .01; perceptual strain: t-statistic =19.198, p-value <.01; blood pressure diastolic: t-statistic=1.244, p-value = n.s.; pulse: t-statistic=1.480, p-value = n.s.). Coping was also significantly related to perceptual strain, blood pressure, and pulse rate, but was insignificantly related to alpha-amylase (alpha-amylase: t-statistic = 1.138, p-value = n.s; perceptual strain: t-statistic =19.117, p-value <.01; blood pressure diastolic: t-statistic=3.147, p-value<.01; pulse: t-statistic=2.351, p-value<.05.).

Second, we compare the beta coefficients of the groups to see the change in beta by moving from one group to another. If the beta coefficient is higher than the coefficient in the low strain group, we can make casual assertions that the model was successful. However, as discussed above, the post hoc tests will formally test for group differences in the next section. Not coping resulted in a beta coefficient of 20.368 for alpha-amylase, 2.665 for perceptual strain, -1.541 for blood pressure diastolic, and -1.541 for pulse. When we allowed subjects to cope, their alpha-amylase went down to 6.077 for alpha-amylase ($\Delta\beta$ =14.291), their level of perceptual strain went down to 2.585 ($\Delta\beta$ =.08), their level of blood pressure diastolic went down to -3.795 ($\Delta\beta$ =2.254), and their level of pulse went down to 2.385 ($\Delta\beta$ =.844).

5.4.4.1.2.2. Model 2: Parameter Estimates

Model 2 used covariates as predictors as opposed to categorical variables. Therefore, instead of examining post hoc tests, the parameter estimates test the overall significance of the hypotheses for each dependent variable. Thus, in this section we test hypotheses 6a and 6b, that resource control and method control negatively moderate the relationship between perceptual stress and strain.

Hypothesis 6a stated that method control negatively moderated the relationship between stress and strain. Our results suggest that this interaction was significantly related to strain (alpha-amylase: $\beta=2.820$, t-statistic = 2.785, p-value $<.01$; perceptual strain: $\beta=.190$, t-statistic = 5.935, p-value $<.01$). While the interaction resulted in a positive beta coefficient, we can only conclude that while method control did lower strain as compared to having no method control, it only flattened out the relationship as opposed to decreasing strain all together.

To further understand this interaction, we tested the simple slopes with alpha-amylase as the dependent variable, which are graphed in Figure 5-7 below. A test of simple slopes categorizes the responses into groups: the high stressed, medium stressed, and low stressed group. Therefore, even though the manipulations of demand stressors were set to induce high amounts of stress, we still found variance, suggesting that some individuals did not feel as stressed as others, and thus responded accordingly. Therefore, while we did not theorize a coping behavior in a low stressed environment, we still were able to test this relationship with the simple slopes.

The test produced three lines: perceptual stress at high levels, medium levels, and low levels. The figure suggests that when perceived stress was high and method control was low, our subjects were strained, however when method control was high (holding stress at high), alpha-amylase significantly decreased (see High Stress line below). This suggests that method control does serve as a coping behavior in high stress environments - thus reconfirming hypothesis 6a.

In a low stressed environment, we found the reverse. Specifically, alpha-amylase went up after enacting method control. This suggests that there may be added stress for adding behaviors when they are *not needed* to cope.[13] Finally, we found that when subjects reported medium amounts of stress, alpha-amylase levels did not seem to based on level of method control. This suggests that stress does need to be high before subject benefit from a coping behavior. Overall, we conclude that method control does moderate the relationship between stress and strain.

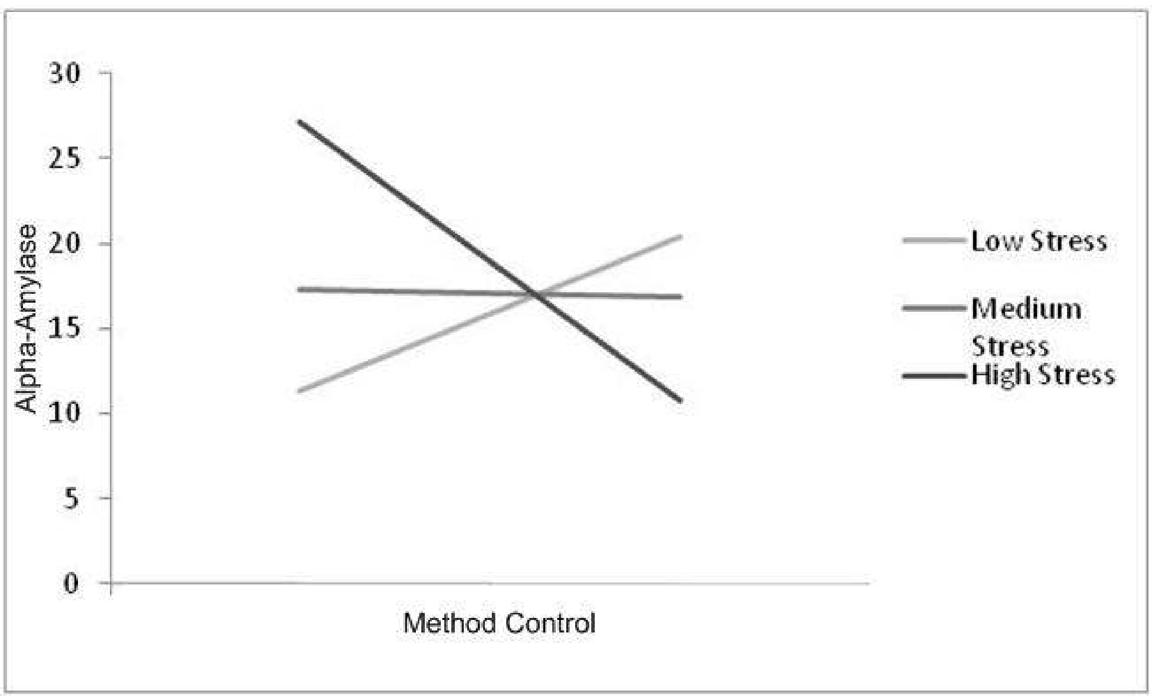


Figure 5-7 Simple Slopes for Method Control

---

[13] We discuss this finding more in Chapter 6.

Hypothesis 6b stated that resource control negatively moderated the relationship between stress and strain. Our results only partially supported this hypothesis. Specifically, the results suggest that this interaction significantly lowered alpha-amylase, while having no affect on perceptual strain (alpha-amylase: β=-2.059, t-statistic = 1.872, p-value <.1; perceptual strain: β=.019, t-statistic = .544, p-value=n.s.).

To further understand this interaction, we tested the simple slopes with alpha-amylase as the dependent variable (See Figure 5-8 below). As in the simple slope test for method control, this test also produced three lines: perceptual stress at high levels, medium levels, and low levels. Each line below shows that resource control significantly reduced alpha-amylase levels regardless of stress being high, medium, or low. Specifically, the figure suggests that when stress was high and resource control was low, our subjects were strained; however, when resource control was high, alpha-amylase levels significantly decreased as stress went up (see High Stress line below). This suggests that resource control does help in high stress environments, thus reconfirming hypothesis 6b. We also found that when resource control was medium and low, alpha-amylase levels also dropped as subjects enacted resource control. This suggests that resource control *always* helped to reduce strain levels, regardless of the level of stress felt. Overall, we conclude that resource control does moderate the relationship between stress and strain.

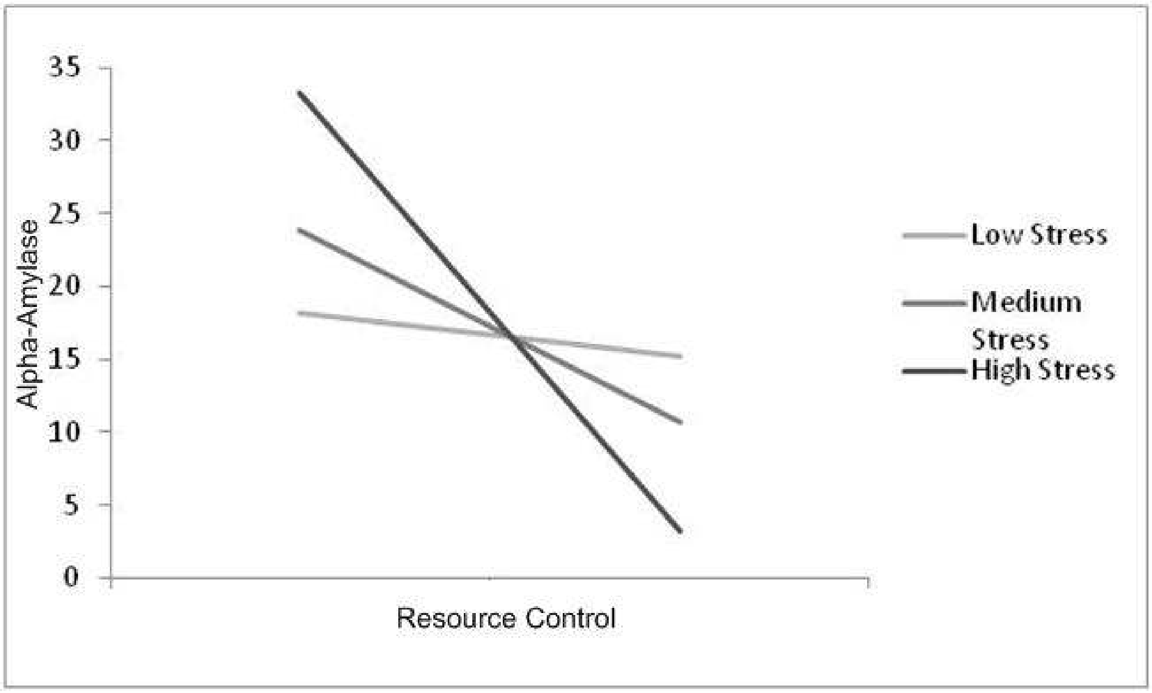


Figure 5-8 Simple Slopes for Resource Control

Table 5-29 Parameter Estimates

Model 1								
Dependent Variable	Parameter	B	Std. Error	T-statistic	P-value	95% Confidence Interval		Partial Eta Squared
						Lower Bound	Upper Bound	
Alpha-Amylase	No Coping*	20.368	5.481	3.716	.000	9.446	31.289	.157
	Coping	6.077	5.339	1.138	.259	-4.561	16.715	.017
Perceptual Strain	No Coping*	2.665	.139	19.198	.000	2.388	2.941	.833
	Coping*	2.585	.135	19.117	.000	2.315	2.854	.832
Blood Pressure Diastolic	No Coping	-1.541	1.238	-1.244	.217	-4.008	.927	.020
	Coping*	-3.795	1.206	-3.147	.002	-6.198	-1.392	.118
Pulse	No Coping	-1.541	1.041	-1.480	.143	-3.615	.534	.029
	Coping*	-2.385	1.014	-2.351	.021	-4.405	-.364	.070
Model 2								

Dependent Variable	Parameter	B	Std. Error	T-statistic	P-value	95% Confidence Interval		Partial Eta Squared
						Lower Bound	Upper Bound	
Alpha-Amylase	MC * Stress*	2.820	1.013	2.785	.007	.804	4.836	.092
	RC * Stress***	-2.059	1.100	-1.872	.065	-4.249	.131	.044
Perceptual Strain	MC * Stress *	.190	.032	5.935	.000	.126	.254	.314
	RC * Stress	.019	.035	.544	.588	-.050	.088	.004
*Significant at .01 ** Significant at .05 ***Significant at .1								

5.5.4.2. T-tests For Dependent Variable

Post-hoc tests examine the differences between the levels of the independent variables with respect to the dependent variables (Fisher, 1942). These tests are univariate tests as opposed to multivariate tests, and thus were only applied after significance was determined by the multivariate F tests. To test for differences, we use the least significant difference (LSD) test for multiple comparisons (See Table 5-30). The null hypotheses of the LSD tests state that a specific group differs from another group on a single dependent variable.

Hypothesis 6 stated that coping behaviors negatively moderated the relationship between perceptual stress and strain. We found partial support for this hypothesis. Specifically, a significant difference in alpha-amylase scores was found between the coping group and the non-coping group ($M_{nocoping} = 20.368$ and $M_{coping} = 6.077$, $p < .1$). Perceptual strain, blood pressure diastolic, and pulse were non-significant.

Table 5-30 Least Significant Difference Test

Dependent Variable	Mean Difference (No Coping - Coping)	Std. Error	P-value
Alpha-Amylase**	14.291*	7.652	.066

Perceptual Strain	.080	.194	.680
Blood Pressure Diastolic	2.254	1.728	.196
Pulse	.844	1.454	.563

5.4.5. Summary of Experiment 2

Table 5-31 provides a summary of results found in Experiment 2.

Table 5-31 Summary of Results

Hypothesis		Supported?	
Hypothesis 6	Coping behaviors moderate the relationship between perceptual stress and strain.	Yes	
Hypothesis 6a	Method control over the ICT negatively moderates the relationship between stress and strain.	Yes	
		Perceptual Strain	Yes
		Alpha-Amylase	Yes
Hypothesis 6b	Resource control associated with escaping from the ICT environment negatively moderates the relationship between perceptual stress and strain.	Partial	
		Perceptual Strain	No
		Alpha-Amylase	Yes

5.6. Conclusion

This chapter provided a detailed discussion on the results obtained from two laboratory experiments in this study. Overall, we found strong support for the majority of the hypotheses.

In terms of demand stressors, we found that overload and message profile significantly affected stress. We also found that timing control moderated the relationship between demand stressors and strain. Specifically, quantitative demand and demand variability significantly lead to overload when timing control was absent. In fact, demand variability was only significant when timing control was absent. However, the interaction of demand variability with timing control had no effect on interruption ambiguity.

We also found that coping significantly reduced strain. In terms of specific coping behaviors, while resource control had no effect on perceptions, we found that the interaction of resource control with stress significantly reversed the beta coefficient decreasing alpha-amylase levels. While the interaction of stress and method control had a significant relationship with strain, when stress was low, it could also serve as a stressor as opposed to a coping behavior.

Table 5-32 provides a summary of results from both experiments.

Table 5-32 Summary of Results

Hypothesis		Supported?
H1	Quantitative demand associated with ICT – enabled interruptions positively affects perceptual overload.	Yes
H2a	Demand variability associated with ICT – enabled interruptions positively affects perceptual overload.	No
H2b	Demand variability associated with ICT – enabled interruptions positively affects perceptual interruption ambiguity.	No
H3a	Message profile affects perceptual message ambiguity.	Yes
H3b	Message profile affects perceptual conflict.	Yes
H4a	Perceptual overload positively affects strain.	Yes
H4b	Perceptual interruption ambiguity positively affects strain.	Partial: (Perceptual Strain: No; Alpha-amylase: Yes)
H4c	Perceptual message ambiguity positively affects strain.	Yes: (Perceptual Strain: Yes; Alpha-amylase: Yes)

H4d	Perceptual conflict positively affects strain.	No
H5a	Timing control over the ICT negatively moderates the relationship between quantitative demand and perceptual overload.	Yes
H5b	Timing control over the ICT negatively moderates the relationship between demand variability and perceptual overload.	Yes
H5c	Timing control over the ICT negatively moderates the relationship between demand variability and perceptual interruption ambiguity.	No
H6	Coping behaviors moderate the relationship between perceptual stress and strain	Yes
H6a	Method control over the ICT negatively moderates the relationship between stress and strain.	Yes
H6b	Resource control associated with escaping from the ICT environment negatively moderates the relationship between perceptual stress and strain.	Partial: (Perceptual Strain: No; Alpha-amylase: Yes)

The next chapter discusses the interpretations of these findings, their implications for research, practice, and theory. We also acknowledge the limitations of the study. We end by discussing future research opportunities.

Chapter 6. Discussion, Implications, and Conclusion

6.1. Introduction

The broad goal of this dissertation was to build a deeper understanding of how ICT factors influence stress in individuals. Our findings helped us understand how ICT – enabled interruptions create episodic stress and how ICTs may also be used to diminish stress evoked by ICT-enabled interruptions.

In Chapter 2, we argued that technostress results from a transactional process in which individuals feel stress induced by stressors, which is consequently manifested in their body as strain. This process also provided the lens to theorize forms of control that diminish stressors' influence. After reviewing the many transactional models of stress, we selected the demands-control model (Karasek, 1979) as the specific theoretical lens used to examine the duality of technology-based stress.

In Chapter 3, the research model hypothesized that objective stressors induce perceptions of stress, which then leads to strain; however, control factors mitigate the effects of high demands on both stress and strain. We focused on stressors that relate to ICT-enabled interruptions and forms of control that can mitigate the effects those specific forms of stress have on strain. Specifically, we examined three stressors: the quantity of the ICT-enabled interruptions (quantitative demand), the variability of the ICT-enabled interruptions (demand variability), and the profile of the message (confounding or cooperating). We then examined how to mitigate stressors' outcomes by testing three moderators of the stressor/strain relationship: ICT-enabled timing control, ICT-enabled method control, and resource control.

In Chapter 4, we described the method used to test the hypotheses in our research model. We discussed the research design and explained why an experiment was the appropriate method for testing our model. Then, we formally discussed the level of analysis: the episode. After discussing the foundation for the study, we set up two laboratory experiments used to test the model. We concluded by describing the stages of analysis that were used to evaluate our hypotheses, including our pretest and pilot data.

The following sections present this dissertation's discussion of results that were presented in Chapter 5, our limitations and future directions, implications of the research findings, and our conclusion.

6.2. Discussion of Results

Our results suggest that ICTs create stress, which leads to strain (see Figure 6-1) but that control factors mitigate the relationship between stress and strain. Out of the six broader hypotheses (with fourteen subcomponents), we found support for the hypotheses involving the following antecedents: quantitative demand, message profile, timing control, overload, message ambiguity, coping, method control, and resource control. We did not find support for demand variability and conflict.

We expand on our results in the following pages. First, we discuss the relationship between perceptual stress and strain. In doing so, we discuss how perceptual strain and objective strain differ in our results. We also provide alternative reasons for the non-significant findings of conflict. Then, we discuss the moderating effect of coping behaviors, including method control and resource control. We discuss how method control can serve both as a stressor and a coping behavior, while resource control always served as a coping behavior (at least in our study). Next, we discuss the relationships between the demand stressors and perceptual stress and conclude with a discussion of the results tied to the moderating effect of timing control.

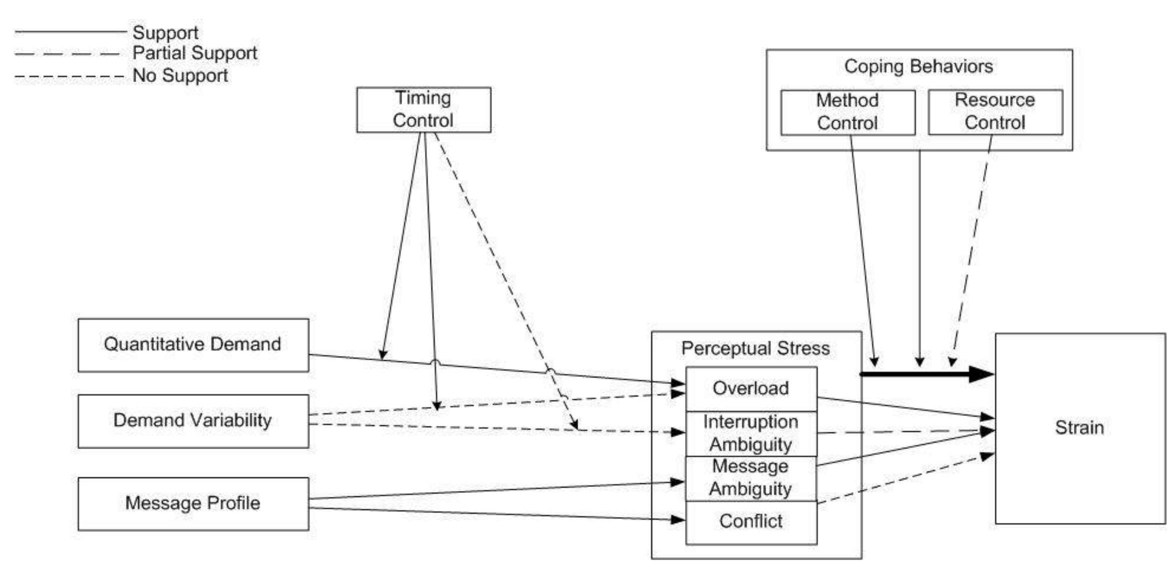


Figure 6-1 Summary of Findings

6.2.1 Predictors of Strain

Our dissertation's results suggest that strain is apparent when stress results from technology-enabled stressors; however, this is more common with objective strain (see

Table 6-1). We also found that coping behaviors moderate the relationship between perceptual stress and strain.

Table 6-1 Predictors of Strain

Hypothesis	Objective Strain?	Perceptual Strain?	Section Number
Perceptual overload positively affects strain.	Yes	Yes	6.2.1.1.1.
Message ambiguity positively affects strain.	Yes	Yes	6.2.1.1.2.
Interruption ambiguity positively affects strain.	Yes	No	
Perceptual conflict positively affects strain.	No	No	6.2.1.1.3.
Coping behaviors moderate the relationship between perceptual stress and strain	Yes	Yes	6.2.1.2.
Method control over the ICT negatively moderates the relationship between stress and strain.	Yes	Yes	6.2.1.2.1.
Resource control associated with escaping from the ICT environment negatively moderates the relationship between perceptual stress and strain.	Yes	No	6.2.1.2.2.

6.2.1.1. Perceptual Stress and Strain

Our analysis tested the relationships from overload, ambiguity (message and interruption), and conflict to strain and revealed that overload positively led to strain, ambiguity partially led to strain, and conflict did not lead to strain.

6.2.1.1.1. Overload

We found that strain was higher when subjects were overloaded. This relationship has been commonly examined in stress research, so our finding was consistent with past research (Perrewe, 1987), even though the setting was novel. In our context, the significance of perceptual overload as a strong predictor of strain implies that individuals have a difficult time managing the demands from a high number of ICT-enabled interruptions. Therefore, *the sheer quantity of interruptions stresses individuals regardless of what the message says or how the message is portrayed to the individual.*

6.2.1.1.2. Ambiguity

Our dissertation examined two types of ambiguity: message ambiguity and interruption ambiguity. In Chapter 3, we hypothesized that these forms of ambiguity would have separate effects on strain: namely, that individuals feel uncertain about what is being communicated in the interruptions (message ambiguity) and about how to process those interruptions (interruption ambiguity). We found that message ambiguity and interruption ambiguity contributed to objective strain (having a non-significant relationship with perceptual strain).

Additionally, we found message ambiguity to be a predictor of strain. More importantly, message ambiguity arose from within the ICT-enabled interruption. This finding implies that individuals have a hard time managing uncertainty, particularly uncertainty stemming from the content of the message or from problems with poorly written and/or poorly communicated ideas(as opposed to the ICT-enabled interruption itself). Based on this result, *we conclude that poor communication stresses individuals.*

Our analyses suggest that interruption ambiguity related to strain occurs at a .1 level (two-tailed test). It is possible that the insignificant result was due to error built into the scale (Garson, 2009). Three plausible explanations for such an error include the following: 1) the subjects did not think interruption ambiguity was an issue and thus marked appropriately, 2) they were unable to comprehend the items as related to the experiment, or 3) the power of the study was insufficient. Even though the items were refined a number of times (five times) in the pretests and pilot study, it is possible that further refinement was necessary to capture significance. *Given the measurement issues, we can only speculate significance of the direct effect of interruption ambiguity on strain.*

6.2.1.1.3. Conflict

We did not find support for conflict leading to strain. This non-significant finding suggests that even if individuals feel uncertainty from a message, the conflicting nature of off-task messages to the primary task is not enough to influence strain. Perhaps this result was due to the laboratory setting: perhaps messages received during a laboratory experiment create a lower cognitive load than off-task messages in the workplace. For example, in our experiment, subjects could easily determine the messages were off-task and could easily move back to the task at hand, thus minimizing the chance that they would feel conflicted. However, in the workplace, individuals might have to spend more time evaluating a message and whether it includes any information related to their many different job roles. With extra cognitive processing required in a natural setting, it is possible that conflict can induce more strain than we found in our laboratory setting.

An alternative explanation we considered was that conflict was ***not*** influenced by a technology stressor (instead it was influenced by the message within the interruption). It is also possible that ICTs are the main source of strain in an interruption-rich environment, while perceptual conflict from the message does not induce strain.

Therefore, even if the respondents felt stressed from mis-communicated messages, their stress did not influence their body enough to create strain. *We conclude that more research is necessary to understand perceptual conflict's relationship with strain.*

6.2.1.2 Moderators of Stress and Strain: Coping

The research model argued that coping behaviors moderate the relationship between stress and strain, thereby attenuating the effects of stress on strain. We found support for the general coping hypothesis when it came to objective strain; however, we found no support that coping was a moderator with perceptual strain. Perhaps coping helps lower the physiological response to stress, while having no effect on what people perceive about their environment. *We conclude that coping helps overcome physiological responses to stress.*

6.2.1.2.1. Method Control

In terms of specific coping behaviors, we examined two influences on strain: 1) the interaction of method control with stress and 2) the interaction of resource control with stress. The interaction of method control as a coping behavior for stress had yet to be tested in an IS context. We found that method control moderated the relationship between stress and strain. However, while method control lowered the relationship between stress and strain, the interaction factor still resulted in strain. After closer examination of this result (by testing the simple slopes), we found that this was due to strain occurring from both high and low feelings of stress (and remaining the same during moderate levels of stress). Specifically, when stress was high, method control worked as theorized (as a coping behavior) - Under high stress, when method control was low, our subjects were strained. Then, when method control was high, subjects strain levels were low. However, when stress was low, we found the reverse relationship. Specifically, an *increase* in strain occurred once subjects enacted method control. This suggests that there may be added stress associated with adding behaviors when they are not enacted as "coping" behaviors. In this sense, when method control was not needed, but was still enacted, it served as a stressor, instead of as a control factor. Finally, when stress was moderate, alpha-amylase levels did not seem to change based on level of the method control. *We can only conclude that while method control did attenuate strain, it only worked in high-stress environments.*

6.2.1.2.1. Resource Control

Next, we tested the interaction of a non-technology factor, resource control. Researchers have previously operationalized resource control as relaxation (Landsbergis, 1988). However, the episodic nature of resource control as a coping behavior of stress has yet to be tested in an IS context. In this dissertation, we only found support for resource control's moderation effect concerning alpha-amylase. This suggests that taking a break and coping can significantly lower an individual's stress hormones, while having no effect on his/her perceptions[14]. To understand resource control's interaction with alpha-amylase further, we conducted a test of the simple slopes and found that resource control significantly reduced alpha-amylase levels regardless of stress being high, medium, or

---

[14] We further expound on the differences between perceptions and alpha-amylase in section 6.4.

low. Specifically, when stress was high and resource control was low, our subjects were strained. Then, when resource control was high, alpha-amylase levels significantly decreased. This was consistent regardless of stress level. *These findings suggest that being in control of a break makes the body less strained just as if the stressors were not present.*

Overall, we determined from both coping behaviors that the best way to mitigate strain was to step away from the ICT environment. Specifically, we found that taking a break not only mitigated stress, but it decreased its effects entirely, while changing the method within the environment only helped lighten the effects of stress.

6.2.2. Predictors of Perceptual Stress

In Chapter 3, we argued that perceptual stress is manifested in overload, conflict, and ambiguity, which results from the demands within an environment and the resources available to a person to meet those demands. The results of this dissertation suggest that perceptual stress occurs as a result of technology-enabled stressors. We also found that timing control moderates the relationship between stressors and perceptual stress. The predictors of overload, ambiguity, and conflict are discussed below and the results are summarized in Table 6-2.

Table 6-2 Predictors of Stress

Perceptual Stress Consequent	Demand Stressor Antecedent	Supported?	Section Number
Perceptual Overload	Quantitative demand associated with ICT-enabled interruptions positively affects perceptual overload.	Yes	6.2.2.1.1.

	Timing control over the ICT negatively moderates the relationship between quantitative demand and perceptual overload.	Yes	
	Demand variability associated with ICT-enabled interruptions positively affects perceptual overload.	No	6.2.2.1.2.
	Timing control over the ICT negatively moderates the relationship between demand variability and perceptual overload.	Yes	
Perceptual Interruption Ambiguity	Demand variability associated with ICT-enabled interruptions positively affects perceptual interruption ambiguity.	No	6.2.2.2.
	Timing control over the ICT negatively moderates the relationship between demand variability and perceptual interruption ambiguity.	No	
Perceptual Message Ambiguity	Message profile affects perceptual message ambiguity.	Yes	6.2.2.2.1.
Perceptual Conflict	Message profile affects perceptual conflict.	Yes	6.2.2.3.

6.2.2.1. Predictors of Overload

6.2.2.1.1. Quantitative Demand and Timing Control

In Chapter 3, we posited that two stressors led to overload—quantitative demand and demand variability—and that the absence of timing control increases these stressors' effects. Our results indicate that quantitative demand significantly led to overload. *This suggests that when ICT-enabled interruptions were more frequent, individuals felt that they could not perform a task because they lacked critical resources.* Next, we tested whether timing control over ICT moderated the relationship between quantitative demand and perceptual overload. We found that when subjects were exposed to a high quantitative demand, stress responses were significantly higher in the absence of timing control as opposed to when participants had timing control. *This suggests that a high number of invasive interruptions are more problematic than controlled interruptions.*

6.2.2.1.2. Demand Variability and Timing Control

We theorized in Chapter 3 that when interruptions fail to arrive at a steady pace, individuals experience negative reactions from both having under-loaded and overloaded demand in a single episode (Fineman et al., 1981). We found a relationship between demand variability and perceptual overload when timing control was absent. However, when timing control was present, the relationship disappeared. We concluded that timing control had to be absent for demand variability to act as a stressor. We can only speculate that when timing control was present, the subjects were unaware that the interruptions were arriving at varying times because they controlled when they checked for messages (i.e., potential interruptions). In contrast, when timing control was absent, the ICT exerted the interruptions upon the individual, thereby compelling the subjects to immediately adhere and adjust to the interruption. *We conclude that when subjects were exposed to high demand variability, stress responses were significantly higher when ICT-enabled timing control was absent as opposed to when ICT-enabled timing control was present.*

6.2.2.2. Predictors of Ambiguity

In Chapter 3, we hypothesized that ambiguity is comprised of message ambiguity and interruption ambiguity. Message ambiguity refers to an uncertainty in the content of the message, while interruption ambiguity refers to an uncertainty when processing the messages. Therefore, message ambiguity stemmed from within the message, while interruption ambiguity stemmed from processing the ICT-enabled interruption. We posited that message profile led to message ambiguity while demand variability led to interruption ambiguity. Further, we hypothesized that timing control moderated the relationship between demand variability and interruption ambiguity.

6.2.2.2.1. Message Profile

We only found support for the hypotheses relating message profile to message ambiguity, suggesting that the profile of the message was more stressful than the interruption itself. This finding supports our theory that off-task messages make realizing the goals of an individual's primary task more difficult to attain, thus causing the individual to feel uncertain about what is being communicated and/or why it is being communicated. *We can conclude that the off-task nature of the message is more important in understanding a stressful environment than having control over the interruption, or in processing the interruptions.*

6.2.2.3. Predictors of Conflict

We posited that having an off-task message profile positively affects perceptual conflict. Our results suggest that conflict was significantly higher when messages were off-task. This suggests that messages unnecessary to the completion of the task at hand make individuals experience an incompatibility in demand. However, as we pointed out in section 6.2.1.2, conflict had no effect on overall strain. *Therefore, while off-task messages do lead to conflict, conflict does not lead to increased strain.*

6.3. Limitations

Prior to discussing the implications of this dissertation, we pause to consider its limitations. The primary limitation is our sample frame relates to our subjects being students who use ICT regularly and have no obvious health problems. Through experimental design, we simulated a working environment, which allowed us to capture the objective nature of strain and generalize it to working individuals. However, the dissertation would have benefited from a less restrictive sample. By selecting college-aged individuals (μ=21), we may have *negatively* biased the results and thus diminished our chances of finding significant results. As individuals grow older, their bodies experience further chronic wear and tear and are thus more susceptible to experience strain from episodic stressors (Marin et al., 2007). On the same point, we also discontinued participation from individuals who were overweight or showed obvious health problems. Working individuals still have to experience interruptions whether they are "healthy" or not. Thus, by limiting our search to healthy individuals, we may have limited our result's generalizability to the broader population. Even though we found significance in our model, our results may have been more dramatic had we not limited our sample frame. Future researchers should consider replicating this study with different age groups to try to capture more variance in the results.

Second, in Chapter 2 we identified a wide variety of demand stressors and coping behaviors; however, this dissertation only hypothesized relationships using three demand stressors and three forms of control. Future researchers could study more of the demand stressors that we presented in Chapter 2, such as various job characteristics (e.g., work hours, temperature, and noise) or support characteristics (e.g., workplace exclusion, source of support). Furthermore, we limited our execution in Chapter 5 to that of an incomplete block design that tested only the hypothesized relationships. We recognize that there may be some interactions occurring that were not theorized and were outside the scope of this dissertation. Future researchers should use our framework to expand our knowledge of technostress.

Third, in Chapter 5, we found that our manipulation of demand variability was not successful due to its inextricable link with timing control. This suggests that demand variability may not have been measured correctly, which could have been the cause for the insignificant findings in our results. However, we were unable to strengthen the manipulation of demand variability during the course of this study. Future researchers should consider testing a stronger manipulation of demand variability, while continuing to explore its link with timing control.

Fourth, in this dissertation, we attempted to cross-tabulate our findings across a number of objective and perceptual variables. However, we later determined that there was very little correlation between measures and that all other objective measures besides alpha-amylase had too much error to shed light into our relationships. Thus, we were unable to triangulate our objective measures of strain, preventing us from achieving our original intent: to increase the validity of the study through the use of multiple dependent variables. Future researchers should try to pinpoint the source of error in the blood pressure and pulse measures before continuing to use these measures in the future.

Finally, we must note the limitation related to sample size. A greater sample size would have allowed us to examine more covariates. By restricting our sample to 180 (90 per experiment), we may have increased the chance of a type II error. However, a type II error is inconsequential when the results are significant (Garson, 2009). Since the majority of our relationships were significant, we conclude that a type II error was not a problem. Future researchers can try to determine a wider variety of covariates that would help provide explanatory power to technostress research.

6.4. Implications for Research

Despite these limitations, this dissertation has several implications for research. Figure 6-2 depicts what we borrowed from and contributed back to the reference disciplines. The following sections expound on these implications concerning episodic stress, ICT-enabled interruptions, message profiles, and coping behaviors.

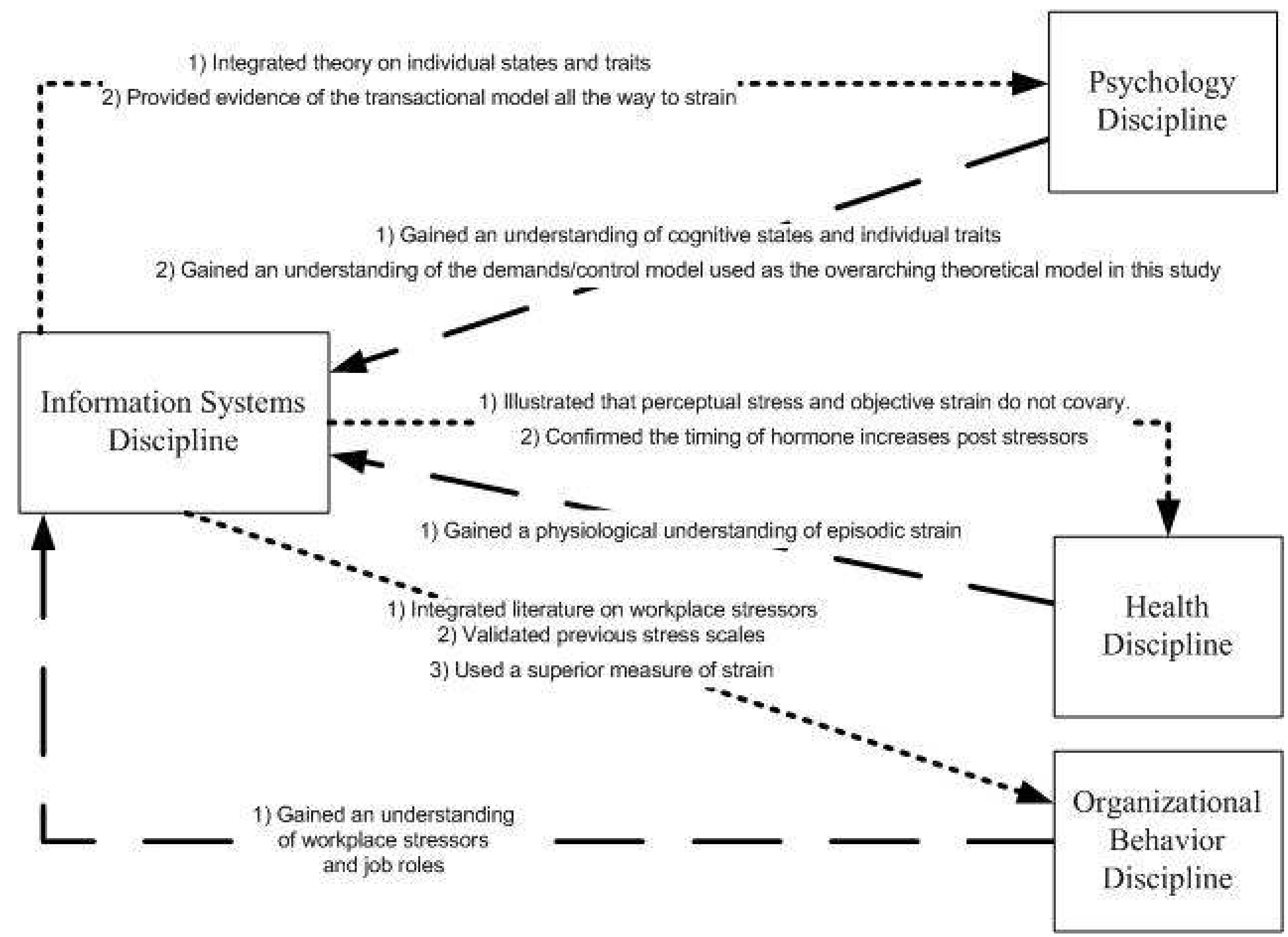


Figure 6-2 Referent Disciplines and IS Research

6.4.1. Implications for IS Research

This dissertation makes several contributions to research. By combining and integrating theory on episodic stress (Selye, 1956; Selye, 1983; Selye, 1993), interruptions (Speier, Valacich, & Vessey, 1997; Speier, Valacich, & Vessey, 1999a; Speier et al., 1999b), and technostress (Ragu-Nathan et al., 2008; Tarafdar et al., 2007), we articulated a novel model of interruption-based stress and laid the foundation for understanding how ICT use can create feelings of strain and actual tension in individuals.

6.4.1.1. Health and Information Systems

The health discipline gave us a physiological understanding of strain. After adopting this measure alongside other perceptual measures used in behavioral science, we discovered that there was virtually a zero correlation between perceptions of strain and alpha-amylase and that while subjects had an increase in their alpha-amylase levels, they may or may not have had the same increase in the way they felt about the situation. This result suggests a previously overlooked mismatch between how people feel and how their body reacts, which goes against conventional thinking that the body and mind parallel each other (Golightly, 1952). We can offer a few explanations for this finding. First, because we limited our sample selection to young, frequent users of the Internet, it may be possible that these subjects were already mentally accustomed to high amounts of interruptions. For example, even if the individual's feelings about the invasiveness of ICT-enabled interruptions have become muddled over time, the interruptions still caused objective strain. Second, individual predispositions may have further biased perceptual measures of strain, while having no effect on alpha-amylase. For example, on the one hand, individuals who view the glass as half-empty (a pessimist) may always remark that they feel stressed even if they are not, while on the opposite hand, optimists may have further trouble admitting stress (even if they are so). This is consistent with the response-based perspective that followed the epidemiological view discussed in Chapter 2, which argued that the body's response will be the same regardless to changes in stressors (Selye, 1983). In this sense, objective changes do occur regardless of how one perceives the environment. Finally, even though our test for common method bias was non-significant, we may have had an issue with common method bias within the relationship between perceptual stress to perceptual strain. It is possible that common method bias may still have been an issue. We conclude from this unique finding that IS researchers should continue to use alpha-amylase in the future when measuring episodic stress.

6.4.1.2. Organizational Behavior and Information Systems

The organizational behavior discipline gave us a fundamental understanding of workplace stressors and job roles. This dissertation adopted this field's theory on job roles to a more fundamental part of workplace stress at the episodic level. In doing so, we extended beyond their research by modeling specific ICT-enabled stressors as antecedents of perceptual episodic stress.

Previously, researchers have focused their models of stress on the perceptions of stress (i.e., role overload) and linked them to chronic outcomes (i.e., job satisfaction, organizational and continuance commitment) (Ragu-Nathan et al., 2008). Such studies not only bypassed objective strain (and theorized directly to chronic outcomes that result from objective strain), but they also ignored the objective stressors that are the original sources of stress. Thus, past research overlooked key factors that stem from the enabling technology. In this dissertation, we repositioned previous researchers "stressors" as our perceptual stress, while further exploring possible objective ICT-enabled stressors that are more likely the true source of strain. Researchers should continue to gather possible antecedents of stress in the future and expand the nomological network surrounding ICTs and stress.

6.4.1.4. Psychology and Information Systems

The psychology discipline provided us with an understanding of cognitive states and individual traits, while also providing us with the theoretical underpinnings of the demands-control model. We expanded the understanding of the demands control by adapting it to a new context at the episodic level, studying specific ICT-enabled demand stressors and control/coping behaviors that affect the link between demand stressors and strain. In doing so, we are amongst the first to manipulate the enabling technology and examine the physiological changes that occur from their enactment.

6.4.2. Implications for Methods

This dissertation includes several contributions to methods. First, we adapted the use of alpha-amylase from health disciplines (Granger et al., 2007) and demonstrated ways for IS researchers to use this technique in the future. We expound on two main points for researchers to take away from this dissertation's use of stress measures. First, we determined that alpha-amylase was not correlated to perceptions. While subjects did not feel that they were overloaded, their body's alpha-amylase level still rose, so their bodies were physiologically overloaded. Ultimately, we concluded that while biases can easily become intertwined with perceptual measures, objective strain tests are more difficult to bias. As such, we found that alpha-amylase was superior to perceptual strain in measuring episodic stress.

Second, this dissertation also contributes by taking a multi-method approach as its experimental design to capture the longitudinal stress process. Experimental designs are superior to survey design because they meet the causality assumptions. Our design was particularly superior because in each hypothesis the two constructs being tested were captured with a unique technique. Specifically, we manipulated the enabling technology and related it to perceptions (objective to perceptual). Then, we related the perceptual outcomes to the objective outcomes. This technique significantly reduced our chance of finding relationships in error.

6.5. Directions for Future Research

While we have provided some avenues for future researchers in both the limitations and implications for research sections, this section discusses additional directions for future research with respect to the overall model, the demand stressors, stress, coping behaviors, and strain (see Figure 6-3). Directly following this section, we discuss the practical implications of this dissertation.

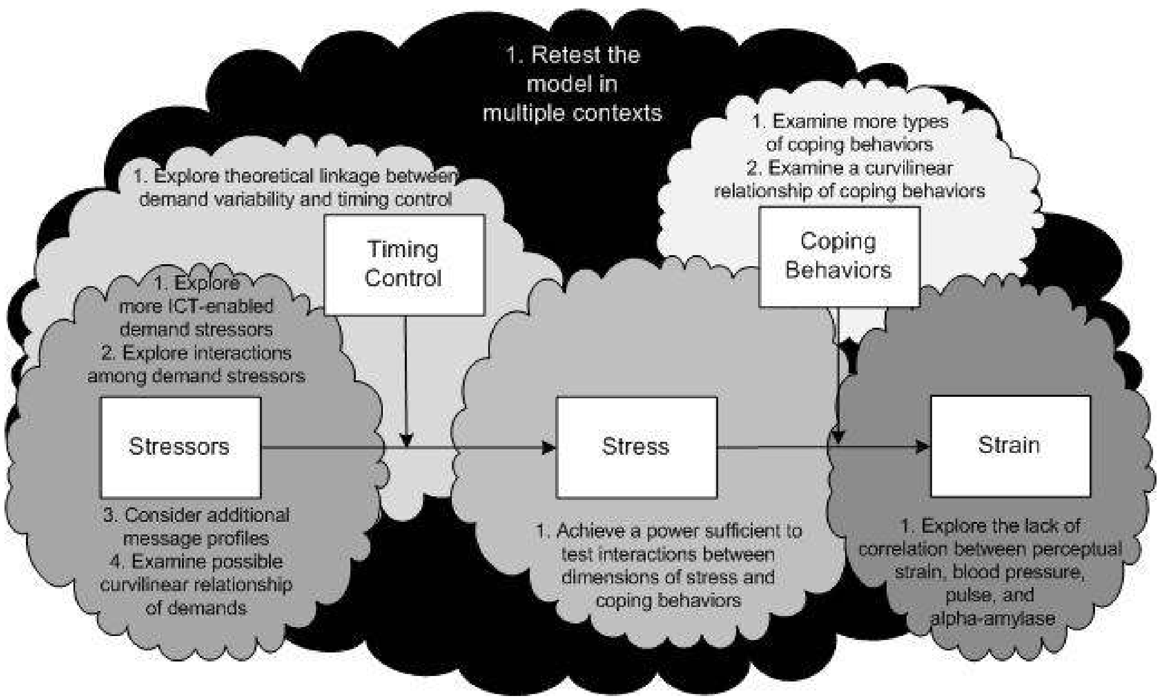


Figure 6-3 Directions for Future Research

6.5.1. The Overall Model

Our focus on ICT-enabled interruptions alongside stress provided the groundwork for researchers to advance our understanding of this pervasive phenomenon in the future. First, we developed objective manipulations for both ICT-enabled stressors and the coping behaviors using a young student sample. We believe that while individual bodies react the same way to stressors, older, less techno-savvy individuals' stress levels could be higher than the population that we sampled from in this dissertation. For example, as individuals grow older, their bodies experience further chronic wear and tear and are thus generally more susceptible to experience strain from episodic stressors (Marin et al., 2007). Similarly, less techno-savvy individuals would also be more likely to experience strain in an ICT-enabled environment because they have not adjusted mentally to constant ICT-enabled interruptions. Future researchers should consider replicating this dissertation with different age groups to try to capture more variance in the results. By also testing different age groups and technology levels, future researchers could shed more light on the unique results we found between perceptual and objective strain.

6.5.2. The Demand Stressors

In chapter 2, we identified a wide variety of demand stressors. However, we only tested three demand stressors and three control factors that we believed help lay the foundation for the study of technostress. We recognize that there may be some interactions occurring that were not theorized and were outside the scope of this dissertation. For instance, perhaps a high quantity of off-task messages (quantitative demand*message profile) interact to produce higher levels of overload: a high number of off-task messages could cause a constant distraction, eliminating the time needed for an individual to refocus on the primary task. Future researchers should continue to examine a greater span of demand stressors along with more informative two- and three-way interactions to understand the full impact of the technostress phenomenon.

Another interesting avenue for future research concerns the curvilinear relationship of quantitative demand. While researchers agree a curvilinear relationship is present between quantitative demand and stress, empirical evaluation on this relationship is limited. For example, Perrewe and Ganster only looked at high and moderate levels of quantitative demand but argue theoretically that low quantitative demand can lead to inattentiveness, boredom, and performance decrements (Perrewe et al., 1989). Others have also left the study of the curvilinear relationship between demands and stress up to future researchers (Van Der Doef et al., 1999). The U-shaped, curvilinear relationship suggests that when quantitative demand is either low or high, stress occurs, while a moderate level of demand does not create stress. We agree that there may be a curvilinear relationship between quantitative demand and stress, which was our original intention in hypothesizing relationships with moderate and high quantities of interruptions in Chapter 3. However, we were unable to test the low relationship with stress; therefore, we leave relationships involving low demand up to future researchers.

Next, in Chapter 5, we found that our manipulation of demand variability was not successful due to its inextricable link with timing control. This suggests that demand variability may not have been measured correctly and thus could have been the cause for the insignificant findings in our results. Future researchers should consider testing a stronger manipulation of demand variability, while continuing to explore its link with timing control.

Finally, we noted in Chapter 3 that message profile refers to the source and type of the instrumental pressure tied to each ICT-enabled interruption. However, we only tested the on-task/off-task nature of the messages, while controlling for source. The social support literature discussed in Chapter 2 suggested that there might be a wider variety of message profiles to examine in the future. For example, how can researchers artificially manipulate the source of the message while also considering how it interacts with the specific content? Research such as this would help uncover important relationships between ill-communicated messages, interpersonal relationships, and stress. We argue that messages are unique to technostress research. Future researchers should expand this research by theorizing about more message factors that will help understand stress.

6.5.3. Coping Behaviors

In this dissertation, we discovered that ICT-enabled method control had to be enacted during high-stress environments for it to be a coping behavior and that if it was enacted in low stress environments, it could actually ***change*** form to be a stressor. This suggests that there may be added strain that occurs from adding behaviors to an individual's job demands when those demands are not needed as "coping" behaviors. In this sense, *when method control was not needed but enacted, it served as a stressor, instead of as a control factor.* This points to a U-shaped, curvilinear relationship, which was different then resource control (the non-ICT coping behavior), which appeared to have a linear relationship with strain. Future researchers should spend time examining a curvilinear relationship with demands and coping behaviors, determining which are curvilinear and which are linear.

6.5.4. Stress

In Chapter 2, we defined perceptual stress as a combination of perceptual overload, perceptual interruption ambiguity, perceptual message ambiguity, and perceptual conflict. However, in Experiment 2, we aggregated this measure into a single dimensional construct: perceptual stress. While the statistics literature confirmed that our aggregation was appropriate, we realize that the dimensions could have interacted with the coping behaviors differently than we found by testing the whole. Our study had insufficient power to test for the interaction between each dimension and each coping behavior with strain. We believe that more interesting relationships could arise from testing more in-depth interactions. Future researchers should take a deeper look at the interplay between dimensions of stress, coping, and strain.

6.5.5. Strain

Finally, to our knowledge, we are amongst the first behavioral science researchers to use alpha-amylase to test for differences from ICT-enabled stressors. However, additional objective measures of strain may help enrich our understanding of technostress. For example, health literature informs us that the interaction of cortisol with alpha-amylase may add extra explanatory power to understanding physiological changes (Gordis, Granger, Susman, & Trickett, 2007). However, since the goal of this study was to understand the episodic stress caused by technology stressors, we focused our stamina on alpha-amylase, while leaving additional objective measures up to future researchers. Specifically, researchers can explore both measures when continuing technostress research in the future, particularly when they move from episodic to chronic stressors. For example, cortisol would be particularly useful in understanding chronic job stressors (discussed in Chapter 2).

6.6. Implications for Practice

This dissertation has several implications for managers seeking to ameliorate some of the deleterious effects of ICT-enabled interruptions (See Table 6-3). First, we discovered that communication is important in preventing stress. Specifically, we found that uncertainty in the message was more problematic than uncertainty in processing the interruption. This suggests that spending time clarifying messages can be more helpful than focusing on explaining processing roles. In the workplace, it may also be possible that the strength of the on-task/off-task nature of the messages would increase, thus making off-task messages more problematic and increasing the need to understand messages. Management should keep workers well informed about their main task and focus on communication so that they can eliminate message ambiguity as a form of stress. If workers have better quality information up front, then they will be more prepared to handle additional messages.

Table 6-3 Implications for Practice

Finding	**Implication for Management**
Communication is important in preventing stress.	Management should keep workers well informed about their main task and focus on communication so that they can eliminate message ambiguity as a form of stress.
Overload is the most significant predictor of strain.	Management should encourage proper time management and clearly delegate responsibilities with interruptions.
Many forms of control help to overcome stress	When stressed by ICTs, it is best for individuals to step completely away from the ICT environment all together. However, if workers cannot take a break and are stressed, they should change their method of working. Workers should be careful that they are not creating any more stress when they are adding behaviors that sometimes help them cope.

Second, we found that interruptions cause individuals to feel overloaded; however, ICTs are increasing the quantity and frequency of interruptions, thus making interruptions more problematic than ever. We found that overload was the most significant predictor of strain, with ambiguity being a close second. In order to reduce the harmful effects from ICT-enabled interruptions, management should encourage proper time management and clearly delegate responsibilities with emails.

Third, our findings underscore the beneficial effects of giving employees control over when they perform behaviors. Business magazines have repeatedly suggested that loss of control is the number one factor in workplace stress[15]. Our results confirm that a loss of control does lead to stress. However, our results extend these anecdotal assertions by also suggesting that characteristics of the enabling technology encourage employees to feel this loss of control, while other factors allow individuals to enact coping behaviors that can help overcome ICT-enabled strain. Specifically, when workers experience interruptions, they often feel out of control*, but even more so when the ICT-enabled interruptions are invasive.* Also, when stressed by ICTs, *it is best for individuals to step completely away from the ICT environment all together*. Therefore, giving workers control over timing not only helped by allowing individuals to turn off invasive interruptions, but it also helped by serving as a coping behavior and allowing individuals to remove themselves from stressful ICT environments during times of stress. In addition,

---

[15] http://www.businessknowledgesource.com/blog/top_10_causes_of_workplace_stress_000810.html
http://ezinearticles.com/?Overcome-the-Top-10-Causes-of-Workplace-Stress&id=1202

we would like to reiterate that it is not about having a break; rather, it is about allowing workers to choose when they need this break (e.g., during the time when they feel most stressed). Management should consider this implication and take away that the main way to reduce stress is to provide flexibility in timing and encourage short amounts of time away from the computer. Then, managers should encourage workers to try to relax during these breaks. These breaks during work hours will help clear out any of the workers' baggage and let their minds reset with lower stress levels. Overall, we conclude that by giving workers more autonomy over the enabling technology and allowing them to cope with the technology, management can help eliminate strain at the source of the stressors.

Finally, we believe that if workers cannot take a break and are stressed, they should change their method of working. However, this implication must be considered only when individuals are stressed. Specifically, we found that giving subjects control over their methods of working with the technology significantly lowered their levels of strain. We did this by giving them access to anything on the World Wide Web, which allowed the subjects to search for additional information that could help them finish their task. Management should be flexible and allow workers to use any online source that will help them get the job done. We are *not suggesting* that management should allow access to all sites; we realize that personal sites, such as Facebook and mySpace, have potential to become problematic in the workplace. In addition, if method control is provided and workers enact it in low stress environments, it can actually cause more strain. Instead, we are suggesting that some online sites are very helpful in gathering and processing information and can benefit a *stressed* individual. Workers and managers should hold informal meetings to discuss potential helpful ICT tools that may help streamline the workload and enhance communication between parties.

By understanding and limiting these workplace stressors and by increasing control in the environment, we hope that organizations can enhance the productivity and profitability of their employees.

6.7. Conclusion

This dissertation takes a more nuanced view of ICTs and directly models how ICT-enabled interruptions influence individual stress when performing a specific type of task. In doing so, we integrated episodic stress and technology with interruption-based research and explained how technology induces stress in individuals when they are performing a specific type of task. Throughout this dissertation, we deepened our understanding of how ICT-enabled interruptions influence individuals' episodic stress and examined possible coping behaviors that show how ICTs can also be used to diminish the stress evoked by interruptions. Although previous research in IS literature has examined perceptual stress, researchers have yet to examine objective strain, specific demand stressors, and specific coping behaviors that mitigate strain

This dissertation offered new avenues to IS researchers by 1) developing a theory of how objective characteristics of technology influence the stressor/strain relationships and 2) testing that theory using best practices from health-related disciplines that examine stress. Considering the pervasiveness of technology-enabled stressors surrounding individuals in work and life, it is important that we understand this phenomenon and continue to identify ways to overcome demand stressors. We believe that this dissertation takes a major step in contributing to the body of knowledge surrounding stress and ICTs. We hope that future researchers will continue this work by exploring different demand stressors and coping behaviors.

Appendices

Appendix 1. Example of Tasks

A.1.1. Uncontrolled Group Instructions

To participate in this study, you have 20 minutes to write a short essay comparable to essays on a standardized test. This response should be greater than 325 words, consist of an introductory paragraph, a body of one or more paragraphs, and a closing paragraph. You must complete this essay in the editor provided below. External resources are not permitted to complete this task.

Use reasons and/or examples from your experience, observation, the Internet, and/or reading to explain your viewpoint. Keep in mind that the point asserted in this response are irrefutable, because the issue is far from 'black-and-white.' It's all a matter of opinion. However, you will be graded on clarity of writing and your critical and reasoning skills

> Reacting to statistics of increased crime and violence, some advocates have argued that it is necessary for the entertainment industry to police itself by censoring television programs and popular music lyrics. However, civil liberties advocates argue that it has not been demonstrated that watching television violence or listening to violent lyrics in songs leads to real violence.

Which argument do you find more convincing: the call for censorship of entertainment media or civil libertarians' whose response to it? Explain your position, using relevant reasons and/or examples from your experience, observations, or reading to support your view point.

Incentives

Essays are graded on a 6 point scale.

Points	Grade	Incentive	
6 points	Exceptional	$10	plus 2 entries for an IPod Touch
5 points	Well done	$8	plus 1 entry for an IPod Touch
4 points	Average	$7	
3 points	Satisfactory	$6	
2 points	Less than Satisfactory	$5	

A.1.2. Controlled Group Instructions

To participate in this study, you have 20 minutes to write a short essay comparable to essays on a standardized test. This response should be greater than 325 words, consist of an introductory paragraph, a body of one or more paragraphs, and a closing paragraph. You must complete this essay in the editor provided below. You have access to the Internet if you would like to search for extra information regarding the topic; however, external resources are not necessary to complete this task. You are allowed an extra 2-minute break at your leisure to rest. In this essence – you have 22 total minutes if you decide to break – else you have 20 minutes.

Use reasons and/or examples from your experience, observation, the Internet, and/or reading to explain your viewpoint. Keep in mind that the point asserted in this response are irrefutable, because the issue is far from 'black-and-white.' It's all a matter of opinion. However, you will be graded on clarity of writing and your critical and reasoning skills.

> The following appeared as part of an article in the business section of a daily newspaper. Company A has a large share of the international market in video-game hardware and software. Company B, the pioneer in these products, was once a $12 billion-a-year giant but collapsed when children became bored with its line of products. Thus Company A can also be expected to fail, especially given the fact that its games are now in so many American homes that the demand for them is nearly exhausted.

In your view, how accurate is the statement above? Use relevant reasons and/or examples from your experience, observations, or reading to support you viewpoint.

Incentives

Essays are graded on a 6 point scale.

Points	Grade	Incentive	
6 points	Exceptional	$10	plus 2 entries for an IPod Touch
5 points	Well done	$8	plus 1 entry for an IPod Touch
4 points	Average	$7	
3 points	Satisfactory	$6	
2 points	Less than Satisfactory	$5	

Appendix 2. Manipulation Checks and Perceptual Scales

Post-Episode Survey					
Below are listed a number of statements which are used to describe the demand you received during the task. Please read each statement carefully and indicate the extent to which each is an accurate or an inaccurate description of your amount of workload during the task.					
Thinking about the interruptions you received while completing the task, answer the following questions.					
	Strongly Disagree	Disagree	Neither Agree or Disagree	Agree	Strongly Agree
Quantitative Demand - The number of ICT-enabled interruptions.					
The number of interruptions was challenging.	1	2	3	4	5
I received too many interruptions during the task.	1	2	3	4	5
I experienced many distractions during the task.	1	2	3	4	5
The interruptions came frequently.	1	2	3	4	5
Demand Variability - The extent that the level of ICT-enabled interruptions remains constant rather than changing from low to high levels.					
The interruptions arrived at an even pace.	1	2	3	4	5
I received varying numbers of interruptions.	1	2	3	4	5
I received interruptions sporadically.	1	2	3	4	5
The interruptions came inconsistently.	1	2	3	4	5
Below are listed a number of statements which are used to describe *the messages in the interruptions* during the task. Please read each statement carefully and indicate the extent to which each is an accurate or an inaccurate description of your experience during the task.					
Message Profile - The level of tangible aid tied to each ICT-enabled interruption.					
Thinking about the messages in the interruptions you received while completing the task, answer the following questions.					
	Strongly Disagree	Disagree	Neither Agree or Disagree	Agree	Strongly Agree
The interruptions helped me accomplish my task.	1	2	3	4	5
The interruptions came from someone with knowledge about my task.	1	2	3	4	5
The interruptions helped me think about my task.	1	2	3	4	5
The interruptions were not related to my task.	1	2	3	4	5
Timing Control - Whether the individual can decide when to view messages, rather than responding to intruding ICTs.					
Below are listed a number of statements which are used to describe the amount of control you experienced during the task. Please read each statement carefully and indicate the extent to which each is an accurate or					

an inaccurate description of your experience during the task.					
	Very Little	Little	Some	Much	Very Much
Did you decide when to check your messages?					
Did you set your own pace to read messages?					
How much control did you have over when to check your messages?	1	2	3	4	5
How much did you set your own pace to read messages?	1	2	3	4	5
How much did you choose when to read your messages?	1	2	3	4	5
Resource Control - Enacting the option to relax from the ICT environment and engage in off-task behaviors.					
I was provided the time to take an efficient break.	1	2	3	4	5
The break gave me the option to take time off from the computer.	1	2	3	4	5
I had control over if I took a break.	1	2	3	4	5
Thinking about the method you used to complete the essay, answer the following questions.					
Method Control - Enacting the option to control how to carry out the technology –based work.					
To what extent did you have …	Not at all	To a very little extent	To some extent	To a great extent	To a very great extent
access to different ways to collect the information required to complete my task.	1	2	3	4	5
control over which sources of information you needed to do my job.	1	2	3	4	5
access to the Internet to complete tasks .	1	2	3	4	5
The sources of information you needed to accomplish the task.	1	2	3	4	5
Below are listed a number of statements which are used to describe *your feelings about stress* during the task. Please read each statement carefully and indicate the extent to which each is an accurate or an inaccurate description of your amount of workload during the task.					
Thinking about how you felt during the task, answer the following questions.					
	Strongly Disagree	Disagree	Neither Agree or Disagree	Agree	Strongl y Agree
Perceptual Overload - Perceiving too many ICT-enabled interruptions given time period.					
I felt overloaded because I received more interruptions than I could process.	1	2	3	4	5

The interruptions made me feel rushed.	1	2	3	4	5
I felt busy due to interruptions.	1	2	3	4	5
The interruptions increased the pressure I felt to get done on time.	1	2	3	4	5
Perceptual Conflict - Perceiving an incompatibility in the demand requirements, where the content of the message conflicts with task.					
I felt tension because interruptions were not relevant to completing the task.	1	2	3	4	5
I felt conflicted because many interruptions did not help me accomplish the task.	1	2	3	4	5
I felt stress because I received interruptions that clashed with my task.	1	2	3	4	5
Message Ambiguity – Feeling uncertain about the message content within the interruptions.					
The messages made me stressed because they contained information that was not relevant to the task.	1	2	3	4	5
The messages made me uncertain because they contained information that was not relevant to the task.					
The information in the messages made me feel uncertain about what to do.	1	2	3	4	5
I was not clear about what I should do with the information in the messages.	1	2	3	4	5
I felt that the content in the messages confused me on how I should complete the task.	1	2	3	4	5
Interruption Ambiguity- Feeling uncertain about the ICT-enabled interruptions.					
I knew what had to be done with the interruptions.	1	2	3	4	5
I felt certain about when to expect interruptions.	1	2	3	4	5
I felt sure when to process interruptions.	1	2	3	4	5
I felt certain about how to respond to interruptions.	1	2	3	4	5
Strain - The psychological and physiological responses of individuals to ICT-enabled demands.					
Below are listed a number of statements which are used to describe *your feelings about strain* do to the task. Please read each statement carefully and indicate the extent to which each is an accurate or an inaccurate description of your feelings as a result of the task.					
Thinking about how you felt as a result of the task, answer the following questions.					
	Strongly Disagree	Slightly Disagree	Neither Agree or Disagree	Slightly Agree	Strongl y Agree

I was drained mentally.	1	2	3	4	5
I suffered from fatigue.	1	2	3	4	5
I felt tired.	1	2	3	4	5
I was strained.	1	2	3	4	5
I felt burned out.	1	2	3	4	5

Appendix 3. Control Variables

Appendix 3a. Episodic Control Variables

Episodic Control Variable Survey					
This scale consists of a number of words that describe different feelings and emotions. Read each item and then mark the appropriate answer in the space next to that word. Indicate to what extent you have felt this way during the task. Use the following scale to record your answers.					
1	2	3	4	5	
Very Slightly or Not at All	A Little	Moderately	Quite a Bit	Extremely	PANAS
	_______ distressed			_______ alert	
	_______ excited			_______ ashamed	
	_______ upset			_______ inspired	
	_______ irritable			_______ determined	
	_______ jittery			_______ attentive	
	_______ strong			_______ active	
	_______ guilty			_______ afraid	
	_______ scared			_______ enthusiastic	
	_______ hostile			_______ proud	
	_______ nervous			_______ interested	
How many messages do you think you received – estimated number? 0-10 11-20 21-40 41-60 >60					

Appendix 3b. Personal Characteristics Control Variables.

Personality Survey						
How many years have you used the Internet?	< 6 mo	>6 mo to < 2 yrs	<2 yrs to < 4 yrs	> 4yrs to < 8	> 8 yrs	Internet Usage
	Very Little	Little	Some	Much	Very Much	
How often do you use the Web to search for information?	1	2	3	4	5	Internet Usage
Below are listed a number of statements used to describe how you view the world.						
Gender:	Male	Female				
Age	______					
Ethnicity	Caucasian /non-Hispanic	Hispanic	Asian	African American	Other	
Class Status	Freshman	Sophomore	Junior	Senior		
Have you had alcohol in the last 24 hours?	No	1 drink	2 drinks	3 drinks or greater		Stress Hormone Controls
Have you had caffeine in the last 2 hours?	No	Very Little	Some	A lot		
Have you had any dairy products or high fructose foods 20 minutes prior to the study?	No	Yes				
Have you eaten a major meal 60 minutes prior to the study?	No	Yes				

Appendix 4. Informed Consent Letter

Consent Form for Participation in a Research Study

Clemson University

The Impact of Information Technology-Enabled Stressors in the Workplace

Description of the research and your participation

As a student at Clemson University, you are invited to participate in this study, designed to measure stress in the workplace. You will be recruited along with approximately 200 other undergraduate students. Your participation and responses will contribute to a comprehensive understanding of employee needs and concerns regarding these processes and supportive activities.

The main goal of this experiment is to examine technological interruptions in IT environments, and provide solutions to this reoccurring problem. In doing so, we examine three broad constructs: demands, technology-enabled controls, and strain. You will be asked to perform a performance task on the computer. During your completion of the task, you will receive a series of interruptions. They will come electronically through instant messenger or email.

The experiment is designed to evaluate performance and stress responses regarding these tasks. To do this, this experiment uses non-invasive tools that capture various indicators of strain at frequent time periods. The tools to be used are salivettes and blood pressure cuffs. Salivettes are a standardized method for capturing salivary stress measures. Blood pressure cuffs are used to examine both blood pressure and pulse rate. Finally, the experiment follows up each episode with a quick survey.

Risks and discomforts

Because our techniques used to measure stress are non-invasive, you will be exposed to minimal risk. However, since the study is designed to examine stress affects, consequently you may feel discomfort from a temporary increase in stress levels. This discomfort is designed to be no more than you would receive in an everyday worklife environment. Results from this empirical study will contribute to a greater understanding of stress and technology in the workplace.

Protection of confidentiality

Your responses will remain confidential. Your name is for the sole purpose of verifying your attendance at Clemson University and to ensure you receive up to $10 incentive for your efforts and are included in the raffle for the iPod touch. We will do everything we can to protect your privacy and your identity will not be revealed in any publication that might result from this study.

In rare cases, a research study will be evaluated by an oversight agency, such as the Clemson University Institutional Review Board or the federal Office for Human Research Protections, that would require that we share the information we collect from you. If this happens, the information would only be used to determine if we conducted this study properly and adequately protected your rights as a participant.

Voluntary participation

Your participation in this research study is voluntary. You may choose not to participate and you may withdraw your consent to participate at any time. Refusal to participate or withdrawal from participation will not involve any penalty or loss of benefits to which you are otherwise entitled.

Early Termination

We desire not to allow persons to participate who have known heart conditions or diagnosed elevated stress levels. Additionally, if these findings become apparent during your participation, the investigator can terminate the participation without your consent. The procedure for an orderly termination will involve the investigator stopping the experiment and asking you how you feel. If issues are confirmed, the investigator will inform you that your participation is finished and the reasonings behind early termination. Early termination will not involve any penalty or loss of benefits to which you are otherwise entitled.

Contact information

The researchers, Ms. Pamela Galluch, can be reached at pgalluc@clemson.edu. Her faculty supervisors, Dr. Jason Thatcher and Dr. Varun Grover, can be reached at jthacher71@clemson.edu and vgrover@clemson.edu. You may contact the Institutional Review Board at 656-6460 if you have any questions regarding your rights as a participant. The duration of the experiment should take approximately 50 minutes and relates to how different technology characteristics can either influence or mitigate stress in the workplace. Upon completion of this study, you will receive an incentive up to $10. The raffle for the iPod Touch will take place after all 200 subjects have completed the experiment.

Consent

Signing this form will imply that you have read and understood the foregoing descriptions of this research project. You are entitled to ask for and receive a satisfactory explanation of any language that you don't fully understand. I have read this consent form and have been given the opportunity to ask questions. I give my consent to participate in this study.

Participant's signature: Date:

A copy of this consent form should be given to you.

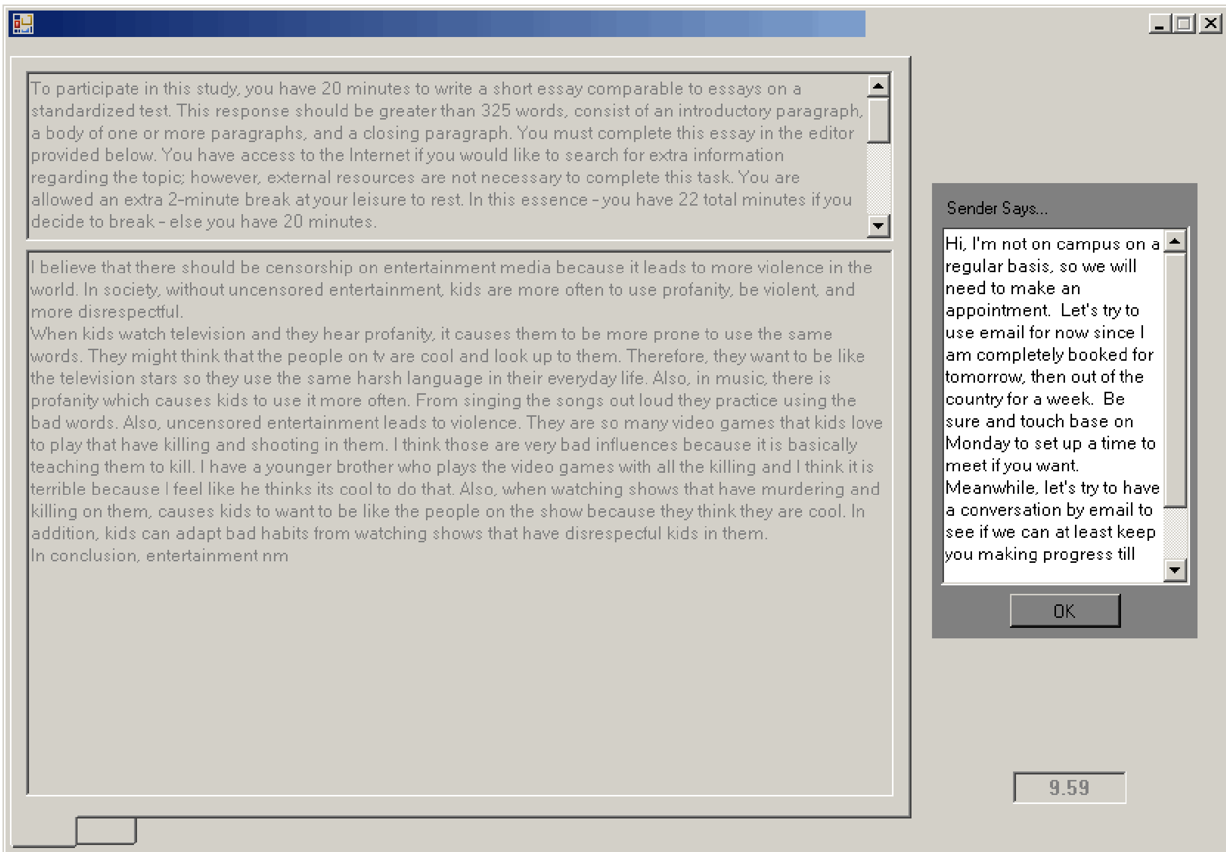
Appendix 5. Factor Loadings

Construct Item	Factor Loading
Quantitative Demand	
QD1	.786
QD2	.781
QD3	.733
QD4	.501
Demand Variability	
DV1	.483
DV2	.484
DV3	.672
DV4	.877
Message Profile	
MP1	.648
MP2	.713
MP3	.829
MP4	.637
Timing Control	
TC1	.599
TC2	.718
TC3	.820
Resource Control	
RC1	.838
RC2	.878
RC3	.771
Method Control	
MC1	.874
MC2	.833
MC3	.740
MC4	.391
Overload	
O1	.762
O2	.894
O3	.819
O4	.822
Message Ambiguity	
MA1	.617
MA2	.775
MA3	.494
MA4	.711
Conflict	
C1	.786
C2	.739
C3	.819
Interruption Ambiguity	
IA1	.630
IA2	.311*
IA3	.803

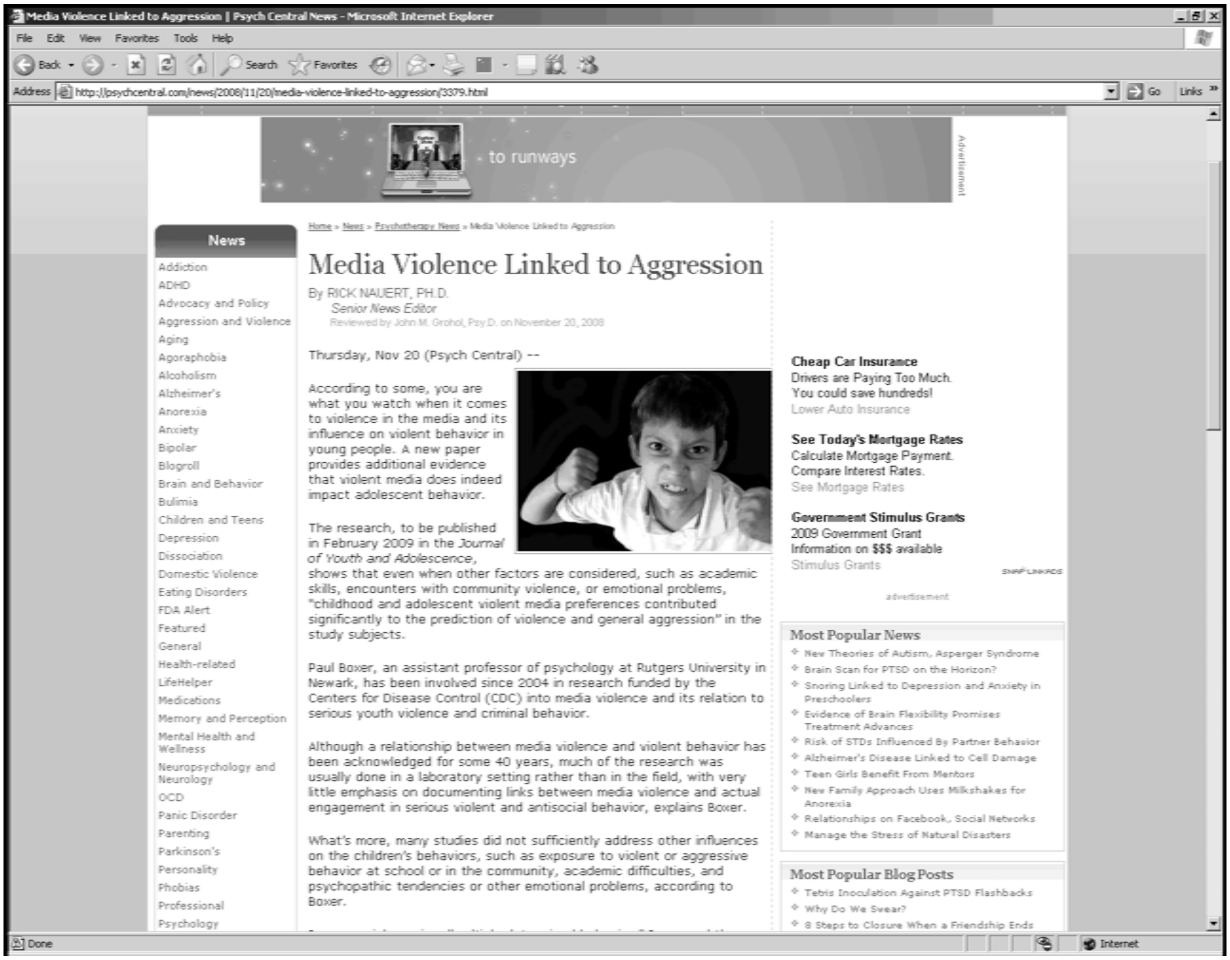
IA4	.625
Perceptual Strain	
S1	.839
S2	.820
S3	.733
S4	.704
S5	.902

Appendix 6. Screenshot Examples

Off-Task (No Timing Control) Interruption



Example of Subject enacting Method Control


Media Violence Linked to Aggression | Psych Central News - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Address http://psychcentral.com/news/2008/11/20/media-violence-linked-to-aggression/3379.html

to runways

Advertisement

Home » News » Psychotherapy News » Media Violence Linked to Aggression

News

Addiction
ADHD
Advocacy and Policy
Aggression and Violence
Aging
Agoraphobia
Alcoholism
Alzheimer's
Anorexia
Anxiety
Bipolar
Blogroll
Brain and Behavior
Bulimia
Children and Teens
Depression
Dissociation
Domestic Violence
Eating Disorders
FDA Alert
Featured
General
Health-related
LifeHelper
Medications
Memory and Perception
Mental Health and Wellness
Neuropsychology and Neurology
OCD
Panic Disorder
Parenting
Parkinson's
Personality
Phobias
Professional
Psychology

Media Violence Linked to Aggression

By RICK NAUERT, PH.D.
Senior News Editor
Reviewed by John M. Grohol, Psy.D. on November 20, 2008

Thursday, Nov 20 (Psych Central) --

According to some, you are what you watch when it comes to violence in the media and its influence on violent behavior in young people. A new paper provides additional evidence that violent media does indeed impact adolescent behavior.

The research, to be published in February 2009 in the *Journal of Youth and Adolescence*, shows that even when other factors are considered, such as academic skills, encounters with community violence, or emotional problems, "childhood and adolescent violent media preferences contributed significantly to the prediction of violence and general aggression" in the study subjects.

Paul Boxer, an assistant professor of psychology at Rutgers University in Newark, has been involved since 2004 in research funded by the Centers for Disease Control (CDC) into media violence and its relation to serious youth violence and criminal behavior.

Although a relationship between media violence and violent behavior has been acknowledged for some 40 years, much of the research was usually done in a laboratory setting rather than in the field, with very little emphasis on documenting links between media violence and actual engagement in serious violent and antisocial behavior, explains Boxer.

What's more, many studies did not sufficiently address other influences on the children's behaviors, such as exposure to violent or aggressive behavior at school or in the community, academic difficulties, and psychopathic tendencies or other emotional problems, according to Boxer.

Cheap Car Insurance
Drivers are Paying Too Much.
You could save hundreds!
Lower Auto Insurance

See Today's Mortgage Rates
Calculate Mortgage Payment.
Compare Interest Rates.
See Mortgage Rates

Government Stimulus Grants
2009 Government Grant
Information on $$$ available
Stimulus Grants

SNAP LINKADS

advertisement

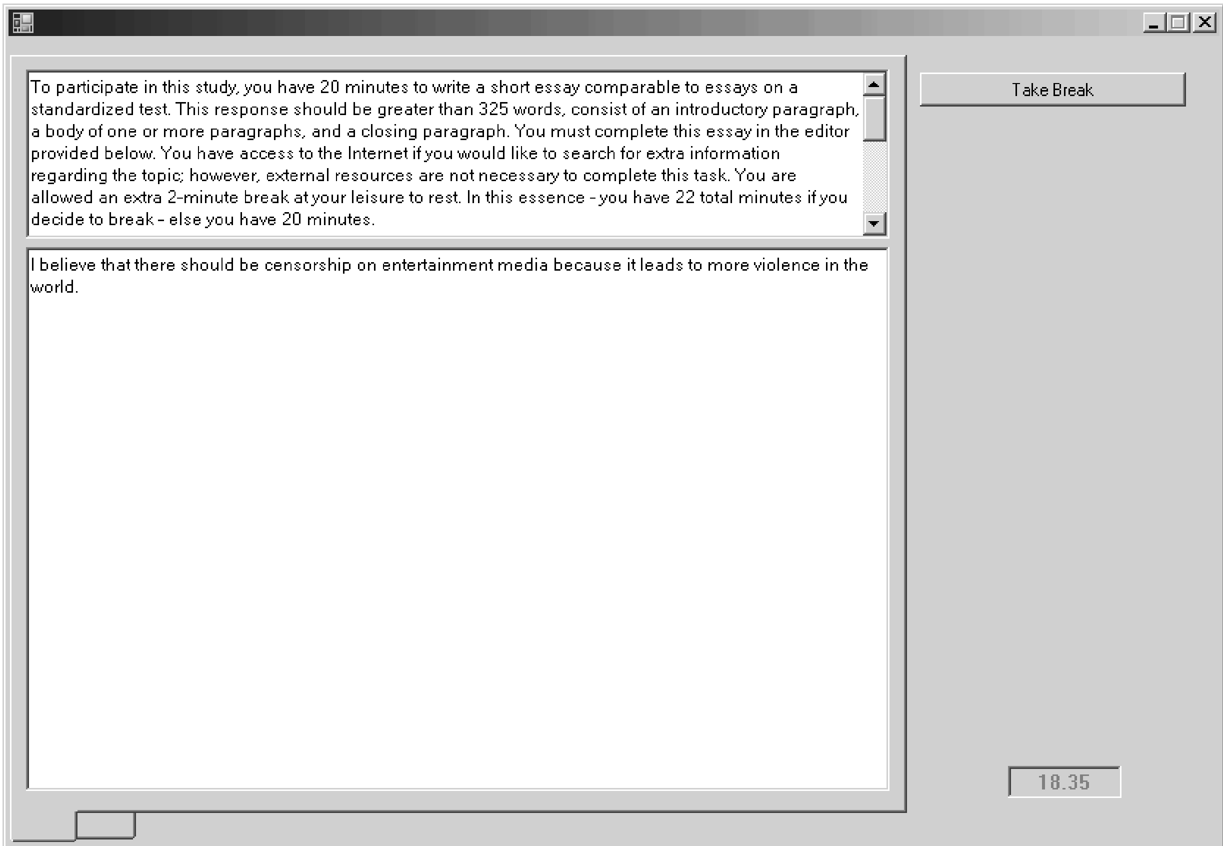
Most Popular News
- New Theories of Autism, Asperger Syndrome
- Brain Scan for PTSD on the Horizon?
- Snoring Linked to Depression and Anxiety in Preschoolers
- Evidence of Brain Flexibility Promises Treatment Advances
- Risk of STDs Influenced By Partner Behavior
- Alzheimer's Disease Linked to Cell Damage
- Teen Girls Benefit From Mentors
- New Family Approach Uses Milkshakes for Anorexia
- Relationships on Facebook, Social Networks
- Manage the Stress of Natural Disasters

Most Popular Blog Posts
- Tetris Inoculation Against PTSD Flashbacks
- Why Do We Swear?
- 8 Steps to Closure When a Friendship Ends

Done

Internet

Example of Break Button



References

Agarwal, R., & Karahanna, E. 2000. Time Flies When You're Having Fun: Cognitive Absorption and Beliefs About Information Technology Usage. ***MIS Quarterly***, 24(4): 665-695.

Agho, A. O., Price, J. L., & Mueller, C. W. 1992. Discriminant validity of measures of job satisfaction, positive affectivity and negative affectivity. ***Journal of Occupational and Organizational Psychology***, 65(2): 185-196.

Aldwin, C., & Revenson, T. 1987. Does coping help? A reexamination of the relation between coping and mental health. ***Journal of Personality and Social Psychology***, 53(2): 337-348.

American Heart Association. 2008. Am I at Risk?, Vol. 2008.

Ariely, D. 2000. Controlling the Information Flow: Effects on Consumers' Decision Making and Preferences. ***Journal of Consumer Research***, 27: 233-248.

Ashford, S. J., Lee, C., & Bobko, P. 1989. Content, Causes, and Consequences of Job Insecurity: A Theory-Based Measure and Substantive Test ***The Academy of Management Journal***, 32(4): 803-829.

Ayyagari, R. 2007. ***What and Why of Technostress: Technology Antecedents and Implications***: Doctoral Dissertation. Clemson University.

Bacharach, S. B., Bamberger, P., & Mundell, B. 1993. Status Inconsistency in Organizations: From Social Hierarchy to Stress. ***Journal of Organizational Behavior***, 14(1): 21-36.

Bauer, J. C., & Simmons, P. R. 2000. Role Ambiguity: A review and integration of the literature. ***Journal of Modern Business***, 3: 41 – 47.

Beal, D. J., Weiss, H. M., Barros, E., & MacDermid, S. M. 2005. An episodic process model of affective influences on performance. ***Journal of Applied Psychology***, 90(6): 1054-1068.

Beaudry, A., & Pinsonneault, A. 2005. Understanding User Responses to Information Technology: A Coping Model of User Adaptation. ***MIS Quarterly***, 29(3): 493-524.

Bedeian, A., Burke, B., & Moffett, R. 1988. Outcomes of Work-Family Conflict Among Married Male and Female Professionals. ***Journal of Management***, 14(3): 475 - 492.

Bedeian, A. G., & Armenakis, A. A. 1981. A Path-Analytic Study of the Consequences of Role Conflict and Ambiguity. ***Academy of Management Journal***, 24(2): 417-424.

Beehr, T. A., Jex, S. M., Stacy, B. A., & Murray, M. A. 2000. Impact of Context on Job Stress Coping: Work Stressors and Coworker Support as Predictors of Individual Strain and Job Performance. ***Journal of Organizational Behavior***, 21(4): 391-405.

Beehr, T. A., Walsh, J. T., & Taber, T. D. 1976. Relationship of stress to individually and organizationally valued states: Higher order needs as a moderator. ***Journal of Applied Psychology***, 61(1): 41-47.

Brillhart, P. E. 2004. Technostress in the Workplace: Managing Stress in the Electronic Workplace. ***Journal of American Academy of Business***, 5(1/2): 302-207.

Budd, J., Arvey, R., & Lawless, P. 1996. Correlates and consequences of workplace violence. ***Journal of Occupational Health Psychology***, 1(2): 197-210.

Byrd O'Brien, T., & DeLongis, A. 1996. The Interactional Context of Problem-, Emotion-, and Relationship-Focused Coping: The Role of the Big Five Personality Factors. ***Journal of Personality***, 64(4): 775-813.

California Occupational Safety and Health Administration. 1995. Cal/OSHA Guidelines for Workplace Security. In D. o. O. S. a. Health (Ed.). San Francisco, CA: State of California: Department of Industrial Relations.

Caplan, R. D. 1987. Person-environment fit theory and organizations: Commensurate dimensions, time perspectives, and mechanisms. ***Journal of Vocational Behavior***, 31: 248–267.

Carlson, D. S. 1999. Personality and Role Variables as Predictors of Three Forms of Work–Family Conflict. ***Journal of Vocational Behavior***, 55: 236-253.

Carlson, D. S., & Perrewé, P. L. 1999. The Role of Social Support in the Stressor-Strain Relationship: An Examination of Work-Family Conflict ***Journal of Organizational Behavior***, 25(4): 513-540.

Carver, C. S., & Scheier, M. F. 1982. Control theory: A useful conceptual framework for personality-social, clinical, and health psychology. ***Psychological Bulletin***, 92: 111-135.

Carver, C. S., & Scheier, M. F. 1990. Origins and functions of positive and negative affect: A control-process view. ***Psychological Review***, 97: 19-35.

Carver, C. S., Scheier, M. F., & Weintraub, J. K. 1989. Assessing coping strategies: A theoretically based approach. ***Journal of Personality and Social Psychology***, 56: 267-283.

Chun, M. M. 2000. Contextual cueing of visual attention. ***Trends in Cognitive Sciences***, 4(5): 170-178

Cohen, A. 1973. ***Industrial noise and medical, absence, and accident record data on exposed workers***. Paper presented at the Proceedings of the second International Congress on noise as public health problem, Washington, DC: EPA.

Cohen, F. 1984. ***Coping***. New York: : Wiley

Cohen, J. 1988. ***Statistical Power Analysis for the Behavioral Sciences*** (Second ed.). Hillsdale, New Jersey, U.S.A.: L. Erlbaum Associates.

Cohen, J. 1992. A Power Primer. ***Psychological Bulletin***, 112(1): 155-159.

Cohen, S. 1980. Aftereffects of Stress on Human Performance and Social Behavior: A Review of Research and Theory. ***Psychological Bulletin***, 88(1): 82-108.

Cohen, S., & Williamson, G. M. 1991. Stress and Infectious Disease in Humans. ***Psychological Bulletin***, 109(1): 5-24.

Cohen, S., & Wills, T. A. 1985. Stress, social support, and the buffering hypothesis. ***Psychological Bulletin***, 98(2): 310-357.

Collie, D. 2005. Top Ten Workplace Stressors, ***Hills Orient***.

Cooper, C. L. 1998. ***Job stress*** Oxford University Press.

Cooper, C. L., Dewe, P. J., & O'Driscoll, M. P. (Eds.). 2001. ***Organizational Stress: A Review and Critique of Theory, Research, and Applications***: Sage Publications, Inc.

Cordes, C. L., Dougherty, T. W., & Blum, M. 1997. Patterns of burnout among managers and professionals: a comparison of models. ***Journal of Organizational Behavior***, 18(6): 685-701.

Courtney, J. 2007. Privacy and Prejudice: An Interruption 2.0 Manifesto for the AlwaysOn Lifestyle: Taking back control of your real time communications in the AlwaysOn world., ***Skype Journal***, Vol. February 21.

Coyne, J. C., & Downey, G. 1991. Social Factors and Psychopathology: Stress, Social Support, and Coping Processes. ***Annual Review of Psychology***, 42(1): 401-425.

Csikszentmihalyi, M. 1990. ***Flow: The psychology of optimal experience***. New York.

Cuesdan, L., Teganeanu, S., Tutu, C., Raiciu, M., Carp, C., & Coatu, S. 1977. Study of cardiovascular and auditory pathophysiological implications in a group of operatives working in noisy industrial settings. ***Psychophysiologi***, 14: 53–61.

Cummings, T. G., & Cooper, C. L. 1979. A cybernetic framework for studying occupational stress. ***Human Relations***, 32: 395-418.

Damrad-Frye, R., & Laird, J. D. 1989. The experience of boredom: The role of self-perception of attention. ***Journal of Personality and Social Psychology***, 57: 315-320.

Daniels, K. 1994. Occupational Stress, Social Support, Job Control, and Psychological Well-Being. ***Human Relations***, 47(12): 1523-1544.

de Jonge, J., Bosma, H., Peter, R., & Siegrist, J. 2000. Job strain, effort-reward imbalance and employee well-being: A large-scale cross-sectional study. ***Social Science & Medicine***, 50: 1317-1327.

Demerouti, E., Bakker, A. B., Nachreiner, F., & Schaufeli, W. B. 2001. The job demands-resources model of burnout. ***Journal of Applied Psychology***, 86(3): 499-512.

Dickerson, S. S., & Kemeny, M. E. 2004. Acute Stressors and Cortisol Responses: A Theoretical Integration and Synthesis of Laboratory Research. ***Psychological Bulletin***, 130(3): 355-391.

Dwyer, D. J., & Ganster, D. C. 1991. The Effects of Job Demands and Control on Employee Attendance and Satisfaction. ***Journal of Organizational Behavior***, 12(7): 595-608.

Edwards, J. R. 1992. A cybernetic theory of stress, coping, and well-being in organizations. ***Academy of Management Review***, 17(2): 238-274.

Edwards, J. R. 1996. An examination of competing versions of the person-environment fit approach to stress. ***Academy of Management Journal***, 39(2): 292-339.

Edwards, J. R., & Cooper, C. L. 1988. Research in stress, coping and health: Theoretical and methodological issues. ***Psychological Medicine***, 18: 15-20.

Fenlason, K. J., & Beehr, T. A. 1994. Social Support and Occupational Stress: Effects of Talking to Others. ***Journal of Organizational Behavior***, 15(2): 157-175.

Fineman, S., & Payne, R. 1981. Role Stress--A Methodological Trap? ***Journal of Occupational Behavior***, 2(1): 51-64.

Fisher, C. D. 1998. Effects of external and internal interruptions on boredom at work: two studies. ***Journal of Organizational Behavior***, 19(5): 503-522.

Fisher, R. A. 1942. ***The design of experiments*** (3rd ed.). London: Oliver & Boyd.

Folkman, S., & Lazarus, R. S. 1980. An analysis of coping in a middle-aged community sample. ***Journal of Health and Social Behavior***, 21: 219-239.

Folkman, S., & Lazarus, R. S. 1985. If it changes it must be a process: study of emotion and coping during three stages of a college examination. ***Journal of Personality and Social Psychology***, 48: 150-170.

Fox, M. L., Dwyer, D. J., & Ganster, D. C. 1993. Effects if stressful job demands and control on physiological and attitudinal outcomes in a hospital setting. ***Academy of Management Journal***, 36(2): 289-318.

Freedheim, D. K., Weiner, I. B., Velicer, W. F., Schinka, J. A., & Lerner, R. M. 2003. ***Handbook of Psychology***: John Wiley and Sons.

French, J., Caplan, R., & Van Harrison, R. 1982. ***The mechanisms of job stress and strain***. Chichester [Sussex]; New York: Wiley.

Fuller, S., Endress, M., & Johnson, J. 1978. The effects of cognitive and behavioral control on coping with an aversive health examination. ***Journal of Human Stress***, 4(4): 18-25.

Ganster, D. C., Fusilier, M., & Mayes, B. 1986. Role of social support in the experience of stress at work. ***Journal of Applied Psychology***, 71(1): 102-110.

Garde, A. H., & Hansen, A. M. 2005. Long-term stability of salivary cortisol. ***Scand J Clin Lab Invest***, 65: 433-436.

Garson, G. D. 2009 Multivariate GLM, MANOVA, and MANCOVA, Vol. 2009.

Gefen, D., & Ridings, C. M. 2002. Implementation Team Responsiveness and User Evaluation of Customer Relationship Management: A Quasi-Experimental Design Study of Social Exchange Theory. ***Journal of Management Information Systems***, 19(1): 47-69.

Gefen, D., & Straub, D. W. 2004. Consumer trust in B2C e-Commerce and the importance of social presence: experiments in e-Products and e-Services. ***Omega***, 32(6): 407-424

Gillie, T., & Broadbent, D. 1989. What Makes Interruptions Disruptive? A Study of Length, Similarity, and Complexity. ***Psychological Research***, 50: 243-250.

Glass, D. C., Reim, B., & Singer, J. E. 1971. Behavioral consequences of adaptation to controllable and uncontrollable noise. ***Journal of Experimental Psychology***, 7: 244-257.

Golightly, C. L. 1952. Mind-Body, Causation and Correlation. ***Philosophy of Science***, 19(3): 225-227

Goodhue, D. L., & Thompson, R. L. 1995. Task-Technology Fit and Individual Performance. ***MIS Quarterly***: 213-236.

Gordis, E. B., Granger, D. A., Susman, E. J., & Trickett, P. K. 2007. Salivary alpha amylase-cortisol asymmetry in maltreated youth. ***Hormones and Behavior***, 53(1): 96-103.

Granger, D. A., Kivlighan, K. T., Fortunato, C. K., Harmon, A. G., Hibel, L. C., Schwartz, E. B., & Whembolua, G. S. 2007. Integration of salivary biomarkers into developmental and behaviorally-oriented research: Problems and solutions for collecting specimens. ***Physiology and Behavior***, 92(4): 583-590.

Greenhalgh, L., & Rosenblatt, Z. 1984. Job Insecurity: Toward Conceptual Clarity ***The Academy of Management Review***, 9(3): 438-448.

Hammer, L. B., Kossek, E. E., Zimmerman, K., & Daniels, R. 2007. Clarifying the Construct of Family-Supportive Supervisory Behaviors (FSSB): A Multilevel Perspective. In P. L. Perrewe, & D. C. Ganster (Eds.), ***Exploring the Work and Non-Work Interface***, Research in Occupational Stress and Well Being ed., Vol. 6: Elsevier.

Harmon, A. G., Towe-Goodman, N. R., Fortunato, C. K., & Granger, D. A. 2008. Differences in saliva collection location and disparities in baseline and diurnal rhythms of alpha-amylase: A preliminary note of caution. ***Hormones and Behavior*** 54: 592–596.

Harrison, R. 1978. ***Person-environment fit and job stress***: Wiley.

Heaney, C., Israel, B., & House, J. 1994. Chronic job insecurity among automobile workers: effects on job satisfaction and health. ***Social Science Medicine***, 38(10): 1431-1437.

Hoel, H., Sparks, K., & Cooper, C. L. 2006. The cost of violence/stress at work and the benefits of a violence/stress-free working environment. In R. c. b. t. I. L. Organization (Ed.).

Hopp, P. J., Smith, C. A. R., Clegg, B. A., & Heggestad, E. D. 2005. Interruption management: The use of attention-directing tactile cues. ***Human Factors***, 47(1): 1-11.

Izawa, S., Sugaya, N., Ogawa, N., Nagano, Y., Nakano, M., Nakase, E., Shirotsuki, K., Yamada, K. C., Machida, K., Kodama, M., & Nomura, S. 2007. Episodic stress associated with writing a graduation thesis and free cortisol secretion after awakening. ***International Journal of Psychophysiology***, 64(2): 141-145.

Jackson, S., & Brashers, D. E. 1994. ***Random factors in ANOVA***. Thousand Oaks, CA: Sage Publications.

Jackson, S. E., & Schuler, R. S. 1985. A meta-analysis and conceptual critique of research on role ambiguity and role conflict in work settings. ***Organizational Behavior and Human Decision Processes***, 36: 16-78.

Jansen, K. J., & Kristof-Brown, A. 2006. Toward a multidimensional theory of person-environment fit. ***Journal of Managerial Issues***, 18(2): 193-214. .

Jett, Q. R., & George, J. M. 2003. Work interrupted: A closer look at the role of interruptions in organizational life. ***Academy of Management Review***, 28(3): 494-507.

Jex, S. M., Bliese, P. D., Buzzell, S., & Primeau, J. 2001. The Impact of Self-Efficacy on Stressor-Strain Relations: Coping Style as an Explanatory Mechanism. ***Journal of Applied Psychology***, 86(3): 401-409.

Kahn, R. L. 1964. ***Organizational Stress: Studies in Role Conflict and Ambiguity***. New York: Wiley.

Kahn, S. J. 1947. Transaction vs. Interaction. ***The Journal of Philosophy***, 44(24): 660-663.

Karasek, R., Russell, R. S., & Theorell, T. 1982. Psysiology of stress and regeneration in job related cardiovascular illness. ***Journal of Human Stress***, 8: 29-42.

Karasek, R. A. J. 1979. Job Demands, Job Decision Latitude, and Mental Strain: Implications for Job Redesign. ***Administrative Science Quarterly***, 24: 285-308.

Kaufmann, G. M., & Beehr, T. A. 1986. Interactions Between Job Stressors and Social Support: Some Counterintuitive Results. ***Journal of Applied Psychology***, 71(3): 522-526.

Keller, E. 2007. Why You Can't Get Any Work Done, ***BusinessWeek***, Vol. Careers.

Kessler, M. 2007. Fridays go from casual to e-mail free, ***USA Today***, Vol. 2007: USA Today.

Kirmeyer, S. L., & Dougherty, T., W. 1988. Workload, Tension, and Coping: Moderating Effects of Supervisor Support. ***Personnel Psychology***, 41(1): 125-139.

Kryter, K. 1994. ***The handbook of hearing and the effects of noise***. NewYork: Academic Press.

Kushnir, T., & Melamed, S. 1991. Work-Load, Perceived Control and Psychological Distress in Type A/B Industrial Workers. ***Journal of Organizational Behavior***, 12(2): 155-168.

Landsbergis, P. A. 1988. Occupational Stress Among Health-Care Workers - A Test of The Job Demands-Control Model ***Journal of Organizational Behavior***, 9(3): 217-239.

Law, K. S., Wong, C.-S., & Mobley, W. H. 1998. Toward a Taxonomy of Multidimensional Constructs. ***Academy of Management Review***, 23(4): 741-755.

Lazarus, R. S. 1993. From Psychological Stress to the Emotions: A History of Changing Outlooks. ***Annual Review of Psychology***, 44: 1-21.

Lazarus, R. S. 1994. ***Psychological stress in the workplace***. Taylor and Francis, New York.

Lazarus, R. S., & Cohen, J. B. 1977. ***Environmental Stress*** New York: Plenum.

Lazarus, R. S., & Folkman, S. 1984. ***Stress, Appraisal, and Coping***. New York.

Leather, P., Beale, D., & Sullivan, L. 2003. Noise, psychosocial stress and their interaction in the workplace ***Journal of Environmental Psychology***, 23(2): 213-222.

Mandler, G. 1975. ***Mind and Emotion***. New York: Wiley.

Mandler, G., & Watson, D. L. 1966. ***Anxiety and the interruption of behaviour***. New York: Academic Press.

Marin, T. J., Martin, T. M., Blackwell, E., Stetler, C., & Miller, G. E. 2007. Differentiating the impact of episodic and chronic stressors on hypothalamic-pituitary-adrenocortical axis regulation in young women. ***Health Psychology***, 26(4): 447-455.

Maslach, C., Schaufeli, W. B., & Leiter, M. P. 2001. Job Burnout. ***Annual Review of Psychology***, 52: 397-422.

Matthews, K., Woodall, K., & Allen, M. 1993. Cardiovascular reactivity to stress predicts future blood pressure status. ***Hypertension***, 22: 479-485.

Mayes, B. T., & Ganster, D. C. 1988. Exit and Voice: A Test of Hypotheses Based on Fight/Flight Responses to Job Stress. ***Journal of Organizational Behavior***, 9(3): 199-216.

McFarlane. 1997. Interruption of People in Human-Computer Interaction: A General Unifying Definition of Human Interruption and Taxonomy. In N. R. Laboratory (Ed.), Technical Report ed.: Washington, DC.

McFarlane. 2002. Comparison of Four Primary Methods for Coordinative the Interruption of People in Human-Computer Interaction. ***Human-Computer Interaction***, 17: 63-139.

McFarlane, D. C., & Latorella, K. A. 2002. The Scope and Importance of Human Interruption in Human-Computer Interaction Design ***Human Computer Interaction***, 17(1): 1-61.

Meyer, D. E., & Kieras, D. E. 1997. A Computational Theory of Executive Cognitive Processes and Multiple-Task Performance: Part 1 Basic Mechanisms. ***Psychological Review***, 104(1): 2-65.

Miller, G. E., Chen, E., & Zhou, E. S. 2007. If it goes up, must it come down? Chronic stress and the hypothalamic-pituitary-adrenocortical axis in humans. ***Psychological Bulletin***, 133(1): 25-45.

Miller, S. M. 1979. Controllability and human stress: Method, evidence and theory. ***Behaviour Research and Therapy***, 17: 287-304.

Monk, C. A., Boehm-Davis, D. A., & Trafton, J. G. 2004. Recovering from interruptions: Implications for driver distraction research. ***Human Factors***, 46(4): 650-663.

Moore, J. E. 2000. One Road to Turnover: An Examination of Work Exhaustion in Technology Professionals. ***MIS Quarterly***, 24(1): 141-168.

Mullarkey, S., Jackson, P. R., Wall, T. D., Wilson, J. R., & Grey-Taylor, S. M. 1997. The impact of technology characteristics and job control on worker mental health. ***Journal of Organizational Behavior***, 18(5): 471-489.

Neuman, J. H., & Baron, R. A. 1998. Workplace Violence and Workplace Aggression: Evidence Concerning Specific Forms, Potential Causes, and Preferred Targets ***Journal of Management***, 24(3): 391-419.

Nohria, N., & Gulati, R. 1996. Is Slack Good or Bad for Innovation? ***Academy of Management Journal***, 39(5): 1245-1264.

Nygaard, A., & Dahlstrom, R. 2002. Role Stress and Effectiveness in Horizontal Alliances. ***Journal of Marketing***: 61-82.

O'Brien, R., & Kaiser, M. 1985. MANOVA method for analyzing repeated measures designs: an extensive primer. ***Psychological Bulletin***, 97(2): 316-333.

Okhuysen, G. A. 2001. Structuring change: Familiarity and formal interventions in problem-solving groups. ***Academy of Management Journal***, 44(4): 794-808.

Parasuraman, S., Greenhaus, J. H., & Granrose, C. S. 1992. Role Stressors, Social Support, and Well-Being Among Two-Career Couples. ***Journal of Organizational Behavior***, 13(4): 339-356.

Parkes, K. R. 1986. Coping in Stressful Episodes - The Role of Individual Differences, Environmental Factors, and Situational Characteristics. ***Journal of Personality and Social Psychology***, 51(6): 1277-1292.

Pearlin, L. I., Lieberman, M. A., Menaghan, E. G., & Mullan, J. T. 1981. The stress process. ***Journal of Health and Social Behavior***, 22: 337-356.

Perrewe, P. L. 1987. The moderating effects of activity level and locus of control in the personal control-job stress relationship. ***International Journal of Psychology***, 22(2): 179-193.

Perrewe, P. L., & Ganster, D. C. 1989. The Impact of Job Demands and Behavioral Control on Experienced Job Stress. ***Journal of Organizational Behavior***, 10(3): 213-229.

Perrewe, P. L., & Zellars, K. L. 1999. An Examination of Attributions and Emotions in the Transactional Approach to the Organizational Stress Process. ***Journal of Organizational Behavior***, 20(5): 739-752.

Peterson, M. F., Smith, P. B., Akande, A., Ayestaran, S., Bochner, S., Callan, V., Cho, N. G., Jesuino, J. C., Damorim, M., Francois, P. H., Hofmann, K., Koopman, P. L., Leung, K., Lim, T. K., Mortazavi, S., Munene, J., Radford, M., Ropo, A., Savage, G., Setiadi, B., Sinha, T. N., Sorenson, R., & Viedge, C. 1995. Role conflict, ambiguity, and overload - A 21-nation study. ***Academy of Management Journal***, 38(2): 429-452.

Petttigrew, A. M. 1972. Information Control as a Power Resource. ***Sociology***, 6(187-204).

Pierce, J. L., Gardner, D. G., Dunham, R. B., & Cummings, L. L. 1993. Moderation by Organization-Based Self-Esteem of Role Condition Employee Response Relationships. ***Academy of Management Journal***, 36(2): 271-288.

Ragu-Nathan, T. S., Tarafdar, M., Ragu-Nathan, B. S., & Tu, Q. 2008. The Consequences of Technostress for End Users in Organizations: Conceptual Development and Empirical Validation. ***Information Systems Research***, 19(4): 417-433.

Rahim, M. A., & Psenicka, C. 1996. A structural equations model of stress, locus of control, social support, psychiatric symptoms, and propensity to leave a job. ***Journal of Social Psychology***, 136(1): 69-84.

Rencher, A. C. 2002. ***Methods of Multivariate Analysis*** (2nd ed.).

Rice, V. H. 2000. ***Handbook of Stress, Coping, and Health: Implications for Nursing Research***.

Rizzo, J. R., House, R. J., & Lirtzman, S. I. 1970. Role Conflict and Ambiguity in Complex Organizations ***Administrative Science Quarterly***, 15(2): 150-163.

Roberts, B. W., & Robins, R. W. 2004. Person-Environment Fit and Its Implications for Personality Development: A Longitudinal Study ***Journal of Personality*** 72(1): 89–110

Rohleder, N., Nater, U. M., Maldonado, E. F., & Kirschbaum, C. 2006. The psychosocial stress-induced increase in salivary alpha-amylase is independent of saliva flow rate. ***Psychophysiology***, 43: 645-652.

Rook, K. S. 1984. The negative side of social interaction: Impact on psychological well-being. . ***Journal of Personality and Social Psychology***, 46(5): 1097-1108.

Rugulies, R., Bultmann, U., Aust, B., & Burr, H. 2006. Psychosocial Work Environment and Incidence of Severe Depressive Symptoms: Prospective Findings from a 5-Year Follow-up of the Danish Work Environment Cohort Study. ***American Journal of Epidemiology***, 163(10): 877-887.

Salanova, M., Peiro, J. M., & Schaufeli, W. B. 2002. Self-efficacy specificity and burnout among information technology workers: An extension of the job demand-control model. ***European Journal of Work and Organizational Psychology***, 11(1): 1-25.

Sales, S. M. 1969. Organizational Role as a Risk Factor in Coronary Disease. ***Administrative Science Quarterly***, 14(3): 325-336.

Salimetrics. 2008, Vol. 2008.

Sawyer, J. E. 1992. Goal and process clarity: Specification of multiple constructs of role ambiguity and a structural equation model of their antecedents and consequences. ***Journal of Applied Psychology***, 77(2): 130-142.

Schaubroeck, J., & Merritt, D. E. 1997. Divergent effects of job control on coping with work stressors: The key role of self-efficacy. ***Academy of Management Journal***, 40(3): 738-754.

Selye, H. 1956. ***The Stress of Life***. New York.

Selye, H. 1983. ***The stress concept: Past, present and future***. New York, NY: John Wiley.

Selye, H. 1993. ***History of the stress concept.*** . New York: Free Press.

Seshadri, S., & Shapira, Z. 2001. Managerial allocation of time and effort: The effects of interruptions. ***Management Science***, 47(5): 647-662.

Shaw, G., Srivastava, E. D., Sadlier, M., Swann, P., James, J. Y., & Rhodes, J. 1991. Stress management for irritable bowel syndrome : a controlled trial. ***Digestion***, 50(1): 36-42.

Shirom, A. 1982. What is Organizational Stress? A Facet Analytic Conceptualization. ***Journal of Occupational Behaviour***, 3(1): 21-37.

Skinner, E. A. 1996. A Guide to Constructs of Control. ***Journal of Personality and Social Psychology***, 7I(3): 549-570.

Smallwood, J., & Schooler, J., W. 2006. The Restless Mind. ***Psychological Bulletin***, 132(6): 946-958.

Smith-Lovin, L., & Brody, C. 1989. Interruptions in Group Discussions: The Effects of Gender and Group Composition. ***American Sociological Review***, 54(3): 424-435

Smith, T. W. 2006. Personality as Risk and Resilience in Physical Health. ***Association for Psychological Science***, 15(5).

Sparks, K., Cooper, C. L., Fried, Y., & Sharom, A. 1997. The effects of hours of work on health: A meta-analytic review. ***Journal of Occupational and Organizational Psychology***, 70: 391-408.

Spector, P. E. 1986. Perceived control by employees: A meta-analysis of studies concerning autonomy and participation at work. ***Human Relations***, 39: 1005-1016

Speier, C., Valacich, J. S., & Vessey, I. 1997. ***The Effects of Task Interruption and Information Presentation on Individual Decision Making***. Paper presented at the Proceedings of the XVIII International Conference on Information Systems, Atlanta.

Speier, C., Valacich, J. S., & Vessey, I. 1999a. The influence of task interruption on individual decision making: An information overload perspective. ***Decision Sciences***, 30(2): 337-360.

Speier, C., Valacich, J. S., & Vessey, I. 1999b. Information overload through interruptions: An empirical examination of decision making. ***Decision Sciences***, 30(2): 337-360.

Spira, J. B. 2007. How Interruptions Impact Knowledge Worker Productivity, ***Executive Summary*** Basex, Inc.

Spirtes, P., Glymour, C., & Scheines, R. 2000. ***Causation, Prediction, and Search***: MIT Press.

Sproull, L., & Kiesler, S. 1986. Reducing social context cues: Electronic mail in organizational communication. ***Management Science***, 32(11): 1492-1512.

Stein, F., & Cutler, S. K. 2001. ***Psychosocial Occupational Therapy: A Holistic Approach*** (2nd ed.): Thomson Delmar Learning.

Stroud, L., Foster, E., Papandonatos, G. D., Handwerger, K., Granger, D. A., Kivlighan, K. T., & Niaura, R. 2009. Stress response and the adolescent transition: Performance versus peer rejection stressors. ***Development and Psychopathology*** 21: 47–68.

Student. 1908. The Probable Error of a Mean. ***Biometrika***, Biometrika.

Tabachnick, B. G., & Fidell, L. S. 1989. ***Using multivariate statistics*** (2nd ed.). New York: Harper & Row.

Tarafdar, M., Tu, Q., Ragu-Nathan, B. S., & Ragu-Nathan, T. S. 2007. The Impact of Technostress of Role Stress and Productivity. ***Journal of Management Information Systems***, 24(1): 301-328.

Taylor, S., Lichtman, R., & Wood, J. 1984. Attributions, beliefs about control, and adjustment to breast cancer. ***Journal of Personality and Social Psychology***, 46(3): 489-502.

Tellegen, A., & Atkingon, G. 1974. Openness to Absorbing and Self-Altering Experiences ("Absorption") a Trait Related to Hypnotic Susceptibility. ***Journal of Abnormal Psychology***, 83: 268-277.

Thatcher, J. B., & Perrewe, P. L. 2002. An Empirical Examination of Individual Traits as Antecedents to Computer Anxiety and Computer Self-Efficacy. ***MIS Quarterly***, 26(4): 381-396.

Thomas, L. T., & Ganster, D. C. 1995. Impact of Family-Supportive Work Variables on Work Family Conflict and Strain - A Control Perspective. ***Journal of Applied Psychology***, 80(1): 6-15.

Thompson, C. 2005. Meet the Life Hackers, ***The New York Times***, Vol. October 16. New York.

Thompson, S. C. 1981. Will it hurn less if I can control it? A complex answer to a simple question. ***Psychological Bulletin***, 90(1): 89-101.

Toffier, B. L. 1981. Occupational Role Development: The Changing Determinants of Outcomes for the Individual. ***Administrative Science Quarterly***, 26(3): 396-418.

Trochim, W. 2004. ***Research Methods: The Concise Knowledge Base***: Atomic Dog Publishing, Inc.

Tsutsumi, A., Umehara, K., Ono, H., & Kawakami, N. 2007. Types of psychosocial job demands and adverse events due to dental mismanagement: a cross sectional study. ***BMC Oral Health***, 7(3).

Tu, Q., Wang, K., & Shu, Q. 2005. Computer-related technostress in China. ***Communications of the ACM***, 48(4): 77-81.

Van Der Doef, M., & Maes, S. 1999. The Job Demand-Control(-Support) Model and psychological well-being: A review of 20 years of empirical research. ***Work & Stress***, 13(2): 87-114.

Van Yperen, N., & Hagedoorn, M. 2003. Do high job demands increase intrinsic motivation or fatigue or both? The role of job control and job social support. ***Academy of Management Journal***, 46(3): 339–348.

Wall, T. D., Corbett, J. M., W., C. C., Jackson, P. R., & Martin, R. 1990. Advanced Manufacturing Technology and Work Design: Towards a Theoretical Framework. ***Journal of Organizational Behavior***, 11(3): 201-219.

Wall, T. D., Jackson, P. R., & Mullarkey, S. 1995. Further evidence on some new measures of job control, cognitive demand and production responsibility. ***Journal of Organizational Behavior***, 16: 431-455.

Wall, T. D., Jackson, P. R., Mullarkey, S., & Parker, S. K. 1996. The demands-control model of job strain. ***Journal of Occupational and Organizational Psychology: a more specific test***, 69(2): 153-166.

Wall, T. D., Kemp, N. J., Jackson, P. R., & Clegg, C. W. 1986. Outcomes of Autonomous Workgroups - A Long-Term Field Experiment ***Academy of Management Journal***, 29(2): 280-304.

Watson, D., & Clark, L. A. 1984. Negative affectivity: The disposition to experience aversive emotional states. ***Psychological Bulletin***, 96: 465-490.

Watson, D., Clark, L. A., & Tellegen, A. 1988. Development and Validation of Brief Measures of Positive and Negative Affect : The PANAS Scales. ***Journal of Personality and Social Psychology***, 54(6): 1063-1070.

Watson, D., & Pennebaker, J. W. 1989. Health Complaints, Stress, and Distress: Exploring the Central Role of Negative Affectivity. . ***Psychological Review***, 96(2): 234-254

Weil, M., & Rosen, L. 1997. ***TechnoStress: Coping With Technology @WORK @HOME @PLAY*** (1st ed.): John Wiley & Sons.

Weiss, J. 1968. Effects of coping responses on stress. ***Journal of Comparative and Physciological Psychology*** 65: 251–260.

Wharton, A. S., & Erickson, R. J. 1993. Managing Emotions on the Job and at Home: Understanding the Consequences of Multiple Emotional Roles. ***Academy of Management Review***, 18(3): 457-486.

Yuan, C.-S., & Bieber, E. J. 2003. ***Textbook of Complementary and Alternative Medicines***: Taylor & Francis.

Zohar, D. 1997. Predicting burnout with a hassle-based measure of role demands. ***Journal of Organizational Behavior***, 18(2): 101-115.