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The Role of Patient Room-Type, Interruptions, and Intrapersonal Resources in Nurse Performance and Well-Being

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Abstract

Interruptions create a complex challenge in health care. Because some interruptions are necessary in health care, they cannot be completely eliminated. Thus, their effects must be appropriately mitigated. To better understand predictors and consequences of interruptions, as well as factors that may mitigate their negative effects, I employed Job Demands-Resources (JD-R) theory, supplemented by additional constructs from organizational behavior and psychology to develop a model of predictors and mitigators of interruptions. Twenty registered nurses providing care on a progressive acute care unit with single- and double-occupancy patient rooms volunteered to participate in this study. The study incorporated nurse-level questionnaires, event-level surveys, observation, and medical record review to test a mediated, moderation multi-level model. Double-occupancy rooms were a significant predictor of interruptions. Interruptions mediated the effect of room-type on perceived stress, but not on the other five dependent variables (task completion rate, medication administration errors, positive affect, and negative affect). While the full mediated, moderation models were not supported, the individual nurse characteristic of conscientiousness was found to have a significant moderating effect on the effect of room-type on perceived stress. Other nurse characteristics tested, but not found to have a significant effect, were stress mindset and psychological resilience.

This study fills significant gaps in interruption research by using theory to develop a single conceptual model that identifies predictors of interruptions and nurse characteristics that may mitigate their effects. Future applications of this research should expand this approach to support nurse selection and training for working in interruptive patient care environments.

Chapter One: Introduction

The Study Problem

Interruptions in the health care setting have gained recognition as operational failures that pose a threat to the delivery of safe, effective, and efficient care. They have been found to be systemic and pervasive in the hospital environment (Grundgeiger & Sanderson, 2009; Rivera-Rodriguez, & Karsh, 2010; Westbrook et al., 2010), negatively impact caregiver performance and well-being, and hinder the delivery of safe, high-quality patient care (Rivera-Rodriguez & Karsh, 2010; Tucker & Spear, 2006; Westbrook, Woods, Rob, Dunsmuir, & Day, 2010; Westbrook et al., 2010). Health care providers readily recognize interruptions as potential causes of medical error (Biron, Loiselle, & Lavoie-Tremblay, 2009; Elfering, Grebner, & Dudan, 2011; Hand & Barber, 2000). Empirically, interruptions have been found to interfere with health care professionals' ability to successfully complete tasks (Westbrook et al., 2010) and double the risk of major clinical error (Westbrook, Colera et al., 2010). These effects are likely because the complex cognitive tasks involved in patient care often require providers' undivided attention, which cannot be achieved in the face of interruptions (Rivera-Rodriguez & Karsh, 2010). Consequently, efforts have been made to reduce their frequency.

It is important to consider, however, that while interruptions in health care may have negative consequences for some, they are often essential to patient care and may result in positive outcomes for others (Rivera-Rodriguez & Karsh, 2010). For example, when nurses

respond to an interruption from an unexpected overhead page to successfully resuscitate a newborn in cardiac arrest, they are called away from their primary care tasks. In this example, the newborn experiences a positive outcome—successful resuscitation. Similarly, when a nurse is caring for a patient in a double-occupancy (DO) patient room, and responds to a request from the patient's neighbor to assist with an alarming bedside monitor, the neighboring patient experiences a positive outcome—relief from hearing the alarm. In both examples, the nurses themselves may also experience positive outcomes, for example, feelings of pride or satisfaction with their work. At the same time, the diversion of the nurses' attention may cause the nurses to neglect the needs of their assigned patients. Additionally, the experience of the interruption would have created additional workload for the nurses, which over time may result in increased feelings of stress and pressure (Beal, Weiss, Barros, & MacDermid, 2005; Li, Magrabi, & Coiera, 2012).

Thus, interruptions create a complex challenge in health care. In the newborn resuscitation example, an interruption resulted in positive outcomes for one patient, but may have negatively affected other patients. The positive outcome for the newborn illustrates that interruptions in the health care setting cannot and perhaps should not be eliminated. To better understand the complex nuances of interruptions, they must be studied with a multifaceted approach that moves beyond a lens focused merely on reducing their frequency.

Additional complexity manifests when one considers the less immediate effects of interruptions. In the newborn resuscitation example, an initial positive outcome resulted for the newborn and possibly for the nurses (e.g., feeling pride or reward for one's work). However, if nurses perceive the interruption as having a negative effect, such as imposing on their time with other patients, the interruption may have a delayed negative affective response such as feelings

of time pressure of stress and (Beal et al., 2005). Indeed, frequent interruptions have been associated with high levels of stress and negative affect in the workplace (Carton & Aiello, 2009; Jett & George, 2003).

To better understand the temporal nature of the effects of interruptions, research must also consider how interruptions take their effect beyond the moments immediately surrounding an interruption, as well as factors that may lessen the deleterious effects of interruptions. Specifically, research should consider factors related to how individuals perceive and respond to interruptions in order to better understand interruptions' effects. Nurses may possess certain intrapersonal (or psychological) resources which buffer against the excess psychological demands imposed by interruptions (Jett & George, 2003). The roles of such intrapersonal resources in nurse performance and well-being have been minimally considered in research examining interruptions in the health care setting (Keers, Williams, Cooke, & Ashcroft, 2013). Yet, a growing body of literature emphasizes the importance of personality and other state/trait characteristics in employee performance and quality of work (Gabriel, Diefendorff, & Erickson, 2011; Harris, Daniels, & Briner, 2003).

While a multitude of these resources have been studied in the organizational behavior literature, this study focuses on three specific resources: stress mindset, conscientiousness, and psychological resilience. These three resources specifically meet the psychological demands of interruptions in that (a) stress mindset influences how nurses perceive and respond to interruption stressors (Crum, Salovey, & Achor, 2013); (b) conscientiousness influences to what extent nurses can maintain focus in the face of interruptions (Steel, 2007); and (c) psychological resilience influences how quickly nurses bounce back from the effects of interruptions (Fredrickson, Tugade, Waugh, & Larkin, 2003; Tugade & Fredrickson, 2004).

Thus, this study seeks to fill multiple gaps in the research on interruptions in the health care setting. I develop a single model that considers both contributing and mitigating factors of interruptions. To this researcher's knowledge, no research to date has empirically tested—in one complete model—the factors that both contribute to the frequency and mitigate the deleterious effects of interruptions. Building on the work of past empirical research, I hypothesize that nurse performance and well-being are negatively affected by interruptions. The role of the built patient care environment is considered a factor that may systematically contribute to the frequency of interruptions. Specifically, frequency of interruptions is hypothesized to differ between two patient room types, SO and DO rooms. In terms of factors that may mitigate the deleterious effects of interruptions, I hypothesize that high levels of positive stress mindset, conscientiousness, and psychological resilience (i.e., nurse characteristics) will lessen interruptions' negative effects at the immediate time of the interruption and over the course of a nurse's shift.

Background

Patient safety. The Institute Of Medicine (IOM) landmark report on patient safety, To Err is Human: Building a Safer Health System (hereafter referred to as To Err is Human), sheds light on the jarring reality that up to 98,000 deaths occur each year in the U.S. health care system as a result of medical error (IOM, 2000). A more recent study puts estimated annual deaths associated with preventable harm at closer to 400,000 (James, 2013). This updated estimate was developed from a meta-analysis of studies which were published over a decade after To Err is Human was released. The continued staggering rate of deaths elucidates how patient harm in hospitals has yet to be curtailed, and continues to warrant serious study towards correcting its root causes.

To Err is Human introduced the idea that broad-based safety improvements in health care can only be brought about by taking a systems perspective to error reduction (IOM, 2000). The systems perspective is based on research findings from a multitude of studies involving errors (i.e., the failure of a planned action to be completed as intended) and breaches of safety in a variety of industries, including high-reliability organizations, as well as research regarding effective organizational and managerial practices (Reason, 2000). This research has revealed one key underlying principle that applies to all of these industries—multiple, complex human and nonhuman elements interact to affect organizational outcomes as interdependent components of a system (Reason, 2000). More specifically, nearly all adverse events involve a combination of active failures committed by individuals working in the system, and latent conditions of the workplace system which can translate into error provoking conditions and create long-lasting holes or weaknesses in the system (Reason, 2000).

In health care, the systems perspective views medical errors as resulting from these interdependent interactions of multiple, complex human and organizational factors (IOM, 2000). Utilizing a systems perspective in health care is important because it emphasizes that past approaches tended to focus on individual providers and led to blaming, a shortsighted approach that isolated the individual as the origin of error. Blaming individuals does not consider the multitude of organizational factors that may contribute to medical errors. At the same time, while it is widely accepted that blaming individuals alone cannot achieve widespread improvements in patient safety, human decisions and actions have been implicated in all organizational errors (IOM, 2004). Thus, research must consider both organization and human components together when attempting to understand medical error.

Medication Administration Errors

Medication errors present a particular challenge to patient safety because of their frequency and potential to do harm. According to the IOM, the average hospital patient can expect more than one medication error each day (Aspden, Wolcott, Bootman, & Cronenwett, 2006). A medication error is any error occurring during any part of the medication-use process (Aspden et al., 2006). Examples include the wrong medication or wrong dose of medication being prescribed, the medication being given to the wrong patient or by the wrong route, or the failure to give a medication to a patient.

These errors have high costs to patients as well as the health care system at large. They can result in direct harm to patients. Numerous incidents of accidental patient death have occurred as a result of medication errors (Aspden et al., 2006). They also increase the cost of health care delivery. According to the IOM, preventable adverse events resulting from medication errors incur an excess of 3.5 billion dollars each year (Aspden et al., 2006).

While medication errors can occur at any stage in the ordering, dispensing, retrieving, and administration process, errors that occur at the time of administration are medication administration errors (MAEs). These errors are the most likely to reach the patient (Bates et al., 1995; Leape et al., 1995) and constitute up to 38% of all medication errors (Leape et al., 1995; McLeod, Barber, & Franklin, March, 2014). Moreover, medication errors that occur during the administration process are the most likely to result in serious harm and death when compared to medication errors that occur in the ordering, dispensing, and retrieving process (Phillips et al., 2001; Raban & Westbrook, 2014). Thus, MAEs warrant special attention.

Role of Nurses

Nurses play a critical role in the U.S. health care system (IOM, 2004). Nurses constitute 49%[1] of the health care workforce, representing the largest health care occupation in the country (Bureau of Labor Statistics, 2016) and supply the largest category of hospital labor (American Association of Colleges of Nursing, 2011). They are often the frontline of health care, playing a large role in patient safety efforts. Nurses monitor and assess patients, provide essential therapeutic care, carry out medical orders, educate patients and families, and often act as integrators and coordinators of patient care (IOM, 2004). In these roles, nurses serve as a crucial link between physician orders and the end-points of patient care (Leape et al., 1995). Indeed, patient monitoring and assessment are consistently identified as important to reducing patient mortality (IOM, 2004; Mitchell & Shortell, 1997). Given their various responsibilities and roles, nurses are essential to influencing how health care is delivered across all aspects of patient care. Thus, any efforts to reduce and mitigate errors are well positioned with nurses.

Nurses and interruptions. It has become clear that interruptions are ubiquitous in nursing care (Grundgeiger & Sanderson, 2009; Rivera-Rodriguez & Karsh, 2010). Over the past several decades, as hospitals have responded to various market and environmental pressures, many of their approaches to increase the efficiency of patient care have targeted nurses (IOM, 2004). As a result, nurses have seen their job design, or the way they are organized to provide patient care, also change. Some of these changes have included personnel reductions which have resulted in nurses caring for more patients, changes in nurses' responsibilities and patient care processes, and changes in management of patient care staff (IOM, 2004). As a result, the types

[1] Calculated from U.S. Department of Labor's Bureau of Labor Statistics Occupational Employment Wages—May 2015 Report: percent of health care work force where total healthcare occupations (denominator) = 12 million; and total number of nurses (numerator) = 2.7 million Registered Nurses, 1.4 million nurse assistants, 820,630 home health aides, 697,250 licenses practical and licensed vocational nurses.

and amount of nurses' work have expanded to sometimes include ancillary tasks such as housekeeping, delivering and retrieving food trays, and transporting patients (IOM, 2004). These expanded duties add to an acute care environment already permeated by interruptive equipment alarms, pages, and urgent requests. In turn, patient care is disrupted and patient safety is threatened (Gordon, Buchanan, & Bretherton, 2008; IOM, 2004).

Built Environment

A primary purpose of the 2004 IOM report was to (a) identify key aspects of nurses' work environment that impact patient safety, and (b) identify potential improvements that might increase patient safety (IOM, 2004). Among others, it indicates workspace design as an organizational factor contributing to nursing errors. This finding aligns with a growing body of literature developed over the last decade which asserts that investments in certain evidence-based design elements have the potential to yield improved patient care outcomes (Stichler, 2008; Ulrich, Zimring, Quan, & Choudhary, 2004; Ulrich et al., 2008). Evidence-based design is defined as "the deliberate attempt to base building decisions on the best available research evidence with the goal of improving outcomes and of continuing to monitor the success or failure for subsequent decision making" (Malkin, 2008, p. 2).

The Agency for Health Research and Quality (2007) released a report favoring evidence-base design. This report suggests that evidence-based design concepts can help hospitals reduce costly and avoidable incidents of patient harm, including medication errors, hospital-acquired infections, and patient falls. In that same year, another study suggested various evidence-based design improvements might address five of the IOM's quality aims: patient-centeredness, safety, effectiveness, efficiency, and timeliness (Henriksen, Isaacson, Sadler, & Zimring, 2007). Thus,

evidence-based design has been recognized by many prominent and influential agencies as a means for improving the health care work system.

Such evidence-based elements run a gamut of physical enhancements to the built health care environment including, but not limited to: views of nature, enhanced ventilation systems, appropriate acoustics and lighting, and improved work settings to enhance work flow and ergonomics. The first comprehensive review of the literature regarding evidence-based design, funded by The Robert Wood Johnson Foundation in partnership with The Center for Health Design, included more than 600 studies linking the built health care environment to four areas: (a) staff stress, fatigue, and effectiveness in the delivery of care; (b) patient safety; (c) stress and outcomes; and (d) overall health care quality and costs (Ulrich et al., 2004). This literature review was later updated by Ulrich and colleagues in 2008 (Ulrich et al., 2008). Combined, the two reviews present a growing body of literature that establishes a relationship between the built hospital environment and key outcomes.

Patient room-type. A particularly salient feature of the built health care environment is the patient room. Among the evidence-based design elements, a trend towards incorporating SO rooms into hospital design has gained consistent prominence in developed countries (Boardman & Forbes, 2011). When compared to multiple-occupancy (i.e., rooms that house two or more patients at a time), SO rooms have been promoted as having positive effects on patient satisfaction and quality of inpatient care in both research and trade literature (Ulrich et al., 2008; Van de Glind, De Roode, & Goossensen, 2007). The literature suggests that SO rooms have the potential to reduce hospital-acquired infections, reduce patient transfers and the associated medical errors, create a less noisy environment, provide superior accommodations for families, demonstrate high patient satisfaction with overall care, and allow for better patient privacy,

confidentiality, and communication with staff (Chaudhury, Mahmood, & Valente, 2005; Ulrich et al., 2008; Van de Glind et al., 2007). Because of this potential, the SO room has been touted as one of the most important design elements for better patient care (Kravitz, 2010). At the same time, it is important to keep in mind that that SO room design is not without its limits. The SO room design has been associated with increased walking time for care providers, because of the additional square footage associated with it. This design is more costly at initial investment, and requires more physical space, maintenance, and higher housekeeping costs (Boardman & Forbes, 2011). Stakeholders may worry that investments in aesthetically pleasing facilities add unnecessary costs to the nation's rising health care bill. For these reasons, the SO room design is not yet the standard in most developing countries' hospitals, nor in developed countries with public health care systems. Moreover, many existing hospitals in the United States have simply not yet updated existing facilities to accommodate SO rooms. Those hospitals without SO rooms must contend with the multiple-occupancy design and its less than ideal implications.

Study Aims and Research Questions

This study seeks to better understand predictors and consequences of interruptions in patient care in the inpatient setting. Within this overarching aim, this study has three specific aims. The first aim is to determine if the built care environment systematically contributes to interruption frequency. Specifically, this study will determine if interruptions occur more frequently in SO-versus DO patient rooms. Thus, this first aim seeks to answer the research question:

1. Does frequency of interruptions differ by patient room type?

The second aim is to understand how interruptions contribute to nurse performance and well-being, where performance is operationalized as task completion and MAE rate, and well-

being is operationalized as nurses' experience of stress and negative emotion. Within this second aim, I seek to answer the following two research questions:

2. Do high levels of interruptions lead to (a) task incompletion, (b) high rates of MAEs, (c) experience of stress, and (d) experience of negative emotion?

3. Do interruptions occurring early in a nurse's shift continue to have negative consequences later in the shift?

Finally, a third aim of this study is to examine whether individual nurse characteristics might buffer against the negative effects of interruptions. Thus, my final research question is:

4. Do certain intrapersonal resources of nurses (operationalized as stress mindset, conscientiousness, and psychological resilience) mitigate the negative effects of interruptions?

Current Study Significance

Findings of this study have several practical implications. First, findings from the study will help to determine whether interruptions occur more often in DO patient rooms when compared to SO patient rooms. Consequently, this study may inform capital investment implications regarding SO or DO rooms. Second, this study will help understand the extent to which interruptions are associated with MAEs, task completion, and nurse well-being. In doing so, this study may contribute to novel learnings and ways to improve quality of patient care. Third, this study seeks to understand the intrapersonal resources of nurses that may mitigate the deleterious effects interruptions. Given that intrapersonal resources are posited to buffer against the effects of interruptions, hospital units may be able to determine whether nurses with certain intrapersonal resources are better equipped to navigate highly interruptive environments. Thus, the study may inform nurse training and recruitment strategies. Additionally, given that some intrapersonal resources, such as stress-mindset, are able to be developed within nurses, hospitals

may invest in interventions to help nurses develop them. Finally, this study will contribute to our knowledge of how interruptions take their toll on work throughout the day. While evidence exists that interruptions have negative consequences in the healthcare setting (Grundgeiger & Sanderson, 2009), our understanding of how interruptions take their effect is limited. To expand on this knowledge, this study will determine if an interruption early in a nurse's shift can have lasting effects later in the nurse's shift.

Theoretical Framework

Job demands-resources (JD-R) theory provided the primary theoretical framework for this study and was used to construct the overarching conceptual model (Bakker & Demerouti, 2007). Job demand-resources categorizes different characteristics of work into two broad categories, job demands or job resources, and suggests that work performance and well-being outcomes develop as a result of an imbalance of these demands and resources (Demerouti, Bakker, Nachreiner, & Schaufeli, 2001). Job demands-resources is a useful theory for understanding individual employee outcomes as a factor of (a) the job demands employees face, and (b) the job resources employees have available to them (Bakker & Demerouti, 2007). Job demands-resources is also useful in that it considers demands and resources as interacting constructs that affect employee performance and well-being (Bakker, Demerouti, & Euwema, 2005). This interaction effect is particularly applicable to this study because it allows for an explicit examination of the interdependency of organizational and human components as promoted by the systems perspective. Interruptions are the specific job demands examined in this study. Nurses' intrapersonal resources are considered internal job resources.

In this study, nurse performance is operationalized as task incompletion and MAEs. Nurse well-being is operationalized as experience of negative and positive emotions and

perceived stress. The intrapersonal resources of interest for this study are stress mindset, conscientiousness, and psychological resilience. Other pertinent control variables are included which may impact nurse response to interruptions according to the empirical literature. These control variables are daily preshift emotion and stress measures, and nurse demographic data to include gender, age, education level, tenure on hospital unit, and total years of work experience as a nurse.

The first hypothesis considers the built environment (i.e., patient room type) as a factor contributing to excessive job demands (i.e., frequency of interruptions). The following four hypotheses consider the impact of interruptions on employee performance (i.e., task completion and MAE) and well-being (i.e., nurse emotion and stress). The remaining three hypotheses consider the role of job resources, specifically intrapersonal resources (i.e., stress mindset, conscientiousness, and psychological resilience), as moderating the effects of interruptions on nurse outcomes.

While JD-R explains that job demands and resources impact employee outcomes, this study contributes to JD-R's application to interruptions integrating additional theories throughout the conceptual framework to develop seven of the eight hypotheses. Hypotheses 2 and 3 employ the concept of cognitive interference to explain how interruptions lead to diminished nurse performance (Jett & George, 2003; Wickens & Hollands, 2000). These hypotheses consider medication administration as a specific type of nurse task that must be fully and accurately completed in order to avoid MAE. Hypothesis 4 supplements JD-R with affective events theory to explain how interruptions lead to diminished well-being (Weiss & Cropanzano, 1996). Hypothesis 5 builds on the JD-R model with the episodic model of performance) to explain how a series of related poor performance episodes throughout the work day may be triggered by a

single interruption (Beal et al., 2005). Hypotheses 6 through 8 also build on JD-R with the episodic model of performance to explain how specific intrapersonal resources of stress mindset (Crum et al., 2013), conscientiousness (Steel, 2007), and psychological resilience (Tugade & Fredrickson, 2004) may protect against or mitigate the posited effects of interruptions on nurse outcomes.

Research Hypotheses

To answer my research questions, I will test the following hypotheses:

1. Does frequency of interruptions differ by patient room type?

H_1: Nurses providing care in DO rooms will experience more interruptions than when providing care in SO rooms.

2. Do increased interruptions lead to (a) task incompletion, (b) high rates of MAEs, (c) experience of stress, and (d) experience of negative emotion?

H_2: Nurses experiencing more interruptions will complete fewer tasks.

H_3: Nurses experiencing more interruptions are more likely to experience MAEs than nurses experiencing fewer interruptions.

H_4: Nurses experiencing more interruptions are more likely to experience stress than nurses experiencing fewer of interruptions.

H_5: Nurses experiencing more interruptions are more likely to experience negative emotion than nurses experiencing fewer of interruptions.

3. Do interruptions occurring early in a nurse's shift continue to have negative consequences later in the shift?

H_6: Perceived stress, negative emotion, incomplete tasks, and/or MAEs occurring during a patient episode will contribute to perceived stress, negative emotion, incomplete tasks, and/or MAEs in subsequent care episodes.

4. Do certain intrapersonal resources of nurses (operationalized as stress mindset, conscientiousness, and psychological resilience) mitigate the negative effects of interruptions?

H_7: The relationship between interruptions and (a) task completion, (b) MAEs, (c) stress, and (d) negative emotions is weaker for those with a positive stress mindset compared to negative stress mindset.

H_8: The relationship between interruptions and (a) task completion, (b) MAEs, (c) stress, and (d) negative emotions is weaker for those high in conscientiousness compared to those low in conscientiousness.

H_9: The relationship between interruptions and (a) task completion, (b) MAEs, (c) stress, and (d) negative emotions is weaker for those high in resilience compared to those low in resilience.

The combined hypotheses form the conceptual model presented in Figure 1.

Data Sources and Analyses

This study used a combination of quantitative data obtained through observation, questionnaire, episodic survey, and medical record review. The observations took place in a single[2] acute care, progressive unit of the Virginia Commonwealth University Health System, with the nurses completing a one-time, structured questionnaire prior to being observed. I also conducted short, episodic surveys with each nurse throughout the observations. These episodic surveys were administered at the onset of each observed nurse's shift, and following each

[2] Should an insufficient sample size be available from this single unit, the study will be expanded to include nurses from an additional unit that houses both SO and DO room types.

observed episode of patient care. The one-time questionnaires obtained nurse demographic information, used as control variables, and measures of nurse intrapersonal resources.

Figure 1. Conceptual Model

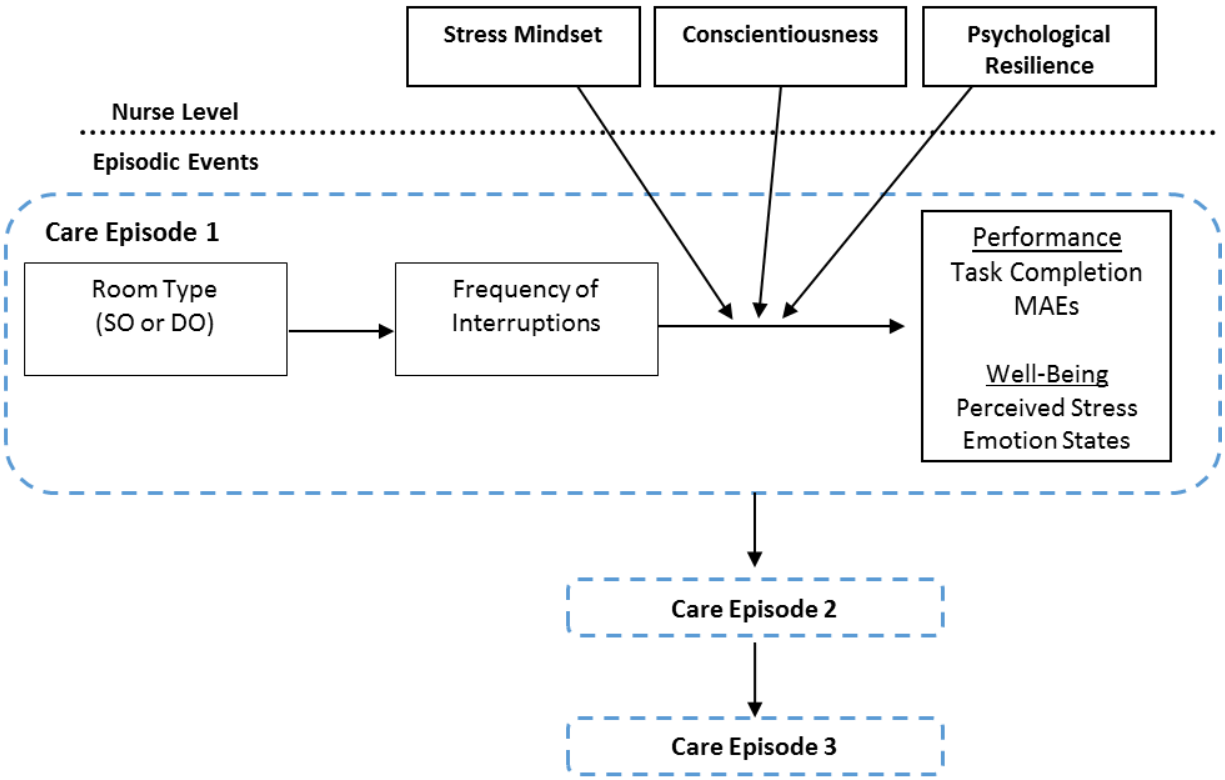


Figure 1. Conceptual model.

Observations provided interruption frequency counts and medication administration data. Episodic surveys provided the following data: preshift affect, experience of positive and negative emotion, successful task completion rate, and perceived stress. Finally, medical record reviews were used to validate MAEs.

Statistical analysis consisted of (a) descriptive statistics of nurse demographics and intrapersonal (i.e., psychological) resources; (b) internal consistency of questionnaire and episodic survey measures; (c) tests for sufficient within-person variance for the episode-level variables; (d) tests of significant differences in interruptions by room-type; (e) mediation effects

of interruptions on the proposed dependent variables of task completion rate, perceived stress, positive affect, negative affect, and MAEs, and finally (f) multilevel modeling was employed to test the empirical ability of each intrapersonal nurse resource to act as a moderator on each dependent variable in initial and subsequent episodes of care. Analysis of single- and multilevel mediation effects were tested utilizing a combination of random coefficient models of mediation (Muthen & Muthen, 1998-2013) and statistical inference through bootstrap confidence intervals via the Monte Carlo Method for Assessing Mediation (MCMAM) (MacKinnon, Lockwood, & Williams, 2004). Analysis of the full multilevel moderated mediation models utilized MPlus® Version 7.31 (Muthen & Muthen, 1998-2013) to estimate a 2-level model with care episodes: (Level-1) nested within nurses (Level-2) via simultaneous path analysis wherein interruptions mediated the relationship between room type and the dependent variables (perceived stress, positive affect, negative affect, task completion, and MAEs), and stress mindset, conscientiousness, and psychological resilience, were entered as cross-level moderators. The moderating effects of the psychological resources were further probed via a simple slope test. Finally, to test the impact of one care episode's outcomes on subsequent care episodes, the dependent variables of each care episode were regressed on all lagged dependent variables from previous care episodes.

Dissertation Outline

Chapter 2 summarizes and identifies gaps in the existing literature on interruptions in health care. In this chapter, three bodies of literature regarding interruptions in health care are explored: sources of interruptions, consequences of interruptions, and possible mitigators of interruptions. Chapter 3 provides the theoretical foundation for this study. The chapter describes JDR's major constructs (job demands and resources) and presents an argument for considering

the interactive effect of its constructs. Chapter 3 further explains the concepts of cognitive interference, affective events, and the episodic model of performance to describe mechanism through which interruptions take their deleterious effects. Chapter 4 describes the study's methodology including the study design, sample, data sources, variables and accompanying measurements, and the analytical techniques used in the study. Chapter 5 presents the results of the study. Finally, Chapter 6 closes with a discussion of the results, recommendations for future research, and the study's limitations.

Chapter 2: Literature Review

This chapter is comprised of four sections summarizing relevant literature involving the study of interruptions. Section I begins with background information regarding how interruptions have been studied and defined in various bodies of literature. This section also includes a summary of findings from experimental lab settings. These lab-based studies have identified many variables contributing to and consequences of interruptions. Their findings have often been extrapolated to the health care setting. Section II then focuses specifically on interruptions studied empirically within health care settings. This section begins with an overview of the state-of-the-science of empirical studies of interruptions in the health care setting. Next, three factors related to interruptions in the health care setting are then explored: (a) antecedents of interruptions, (b) consequences of interruptions, and (c) efforts to mitigate the effects of interruptions. Finally, Section III concludes the chapter by summarizing gaps in the health care literature and how this study seeks to fill them.

Section I: Background Literature

Perspectives of Interruptions

Interruptions are ubiquitous to organizational life, occurring frequently in a variety of contexts and forms (Jett & George, 2003). They have been studied in many settings including, but not limited to, hotels and restaurants (Berger & Merritt, 1998), commercial telecommunications (Eyrolle & Cellier, 2000; Wajcman & Rose, 2011), education (Thomas &

Ayres, 1998), and aviation (Dismukes, Young, & Sumwalt, 1999). The role of interruptions in organizational life has been considered through many lenses. For example, psychologists have considered interruptions from points of view to include cognitive science (Chisholm, Dornfeld, Nelson, & Cordell, 2001; Gillie & Broadbent, 1989; Speier, Valacich, & Vessey, 1999), stress management (Cartwright & Cooper, 1997), and personality and social psychology (Kirmeyer, 1988). Management scholars have considered interruptions in terms of time management (Coates, 1990; Perlow, 1999), employee effectiveness (Argyris & Schon, 1974; Fisher, 1998; Oldham, Cummings, Mischel, Schmidtke, & Zhou, 1995), and job design (Elsbach, 2001). Similarly, engineers have considered interruptions as issues related to technology and computer science (Cutrell, Czerwinski, & Horvitz, 2001; Henning, Jacques, Kissel, Sullivan, & Alteras-Webb, 1997), ergonomics (Henning, Sauter, Salvendy, Krieg, & Edward, 1989), and human factors engineering (Cutrell et al., 2001).

The various disciplines studying interruptions at work have interpreted interruptions in different ways, offering incomplete conceptualizations of interruptions. Some researchers consider interruptions as unscheduled events, initiated by another person, which impose the need to spend time on activities unnecessary to completion of primary tasks (Coates, 1990). Others have considered interruptions as self-initiated breaks, or temporary pauses in work, to accommodate personal needs (Henning et al., 1989). Interruptions have also been considered as psychological in nature wherein a distraction is triggered within an individual by some internal or external trigger, as opposed to an event noticeable to others (Gillie & Broadbent, 1989; Wickens & Hollands, 2000).

Two articles clarify these disparate perspectives of interruptions, offering an increasingly complete conceptualization of interruptions. They are described next. The first develops a

taxonomy of interruptions (Jett & George, 2003). The second identifies key features of the interruption process (Trafton & Monk, 2007).

Interruption Taxonomy

Jett and George (2003) developed a classification of interruptions based on a literature review of cross-discipline studies. Their taxonomy categorizes interruptions as intrusions, breaks, distractions, and discrepancies. They define each category of interruptions in the following way: an intrusion as "an unexpected encounter initiated by another person that interrupts the flow and continuity of an individual's work and brings that work to a temporary halt" (p. 495); a break as "a planned or spontaneous recess from work on a task that interrupts the task's flow and continuity" (pp. 497-498); a distraction as a "psychological reaction triggered by external stimuli or secondary activities that interrupt focused concentration on a primary task" (p. 500); and discrepancies that occur "when an individual perceives significant inconsistencies between his or her expectations and what is happening in the external environment" (p. 502). A discrepancy can occur when the work system fails to reliably provide the information, services, and supplies needed to complete a task, or when the employee lacks the skill or knowledge to complete a task. Discrepancies interrupt the automatic processing of task-related information (Jett & George, 2003).

Key Features of Interruptions

Trafton and Monk (2007) developed a model of key features of the interruption process based on natural observations of simple tasks. In the model, they show seven parts of the interruption process wherein: (a) prior to an interruption, a person works on a primary task; (b) the person is then alerted to a secondary task which can occur through multiple channels (e.g., phone loud noises, face-to-face communications); (c) the person has a period of time, or an

"interruption lag," before he of she turns attention to the secondary task; (d) the person begins and (e) completes the secondary task; (f) a "resumption lag" occurs during which the person must remember the primary task including where in the primary task completion process he or she was; and (g) the person resumes the primary task (Trafton & Monk, 2007, p. 114). A figure (see Figure 2) of Trafton and Monk's model is provided.

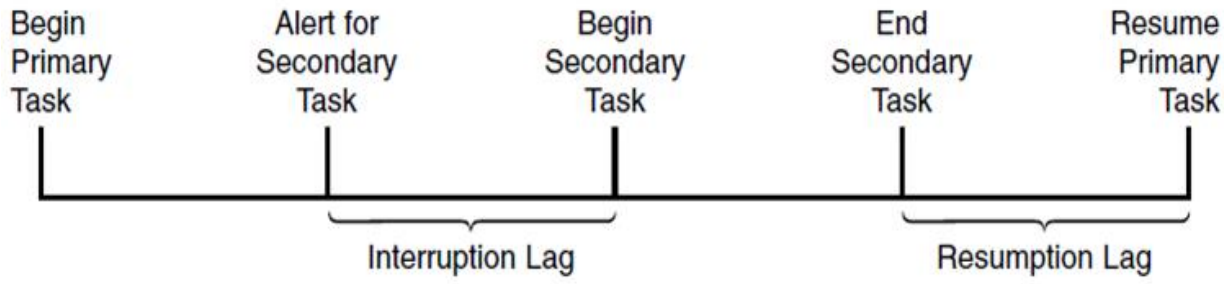


Figure 2. The Trafton and Monk model. Adapted from "Task Interruptions," by J. G. Trafton and C. A. Monk, 2007, *Ergonomics, 3*(1), p. 111-126.

This process model highlights two important aspects of interruptions: (a) task switching is a large component of interruptions, and (b) different aspects of the cognitive system, to include memory and executive function, are important factors in primary task resumption (Trafton & Monk, 2007).

Findings from Laboratory Experiments

The majority of research directly linking interruptions to deleterious effects has been studied through experimental design in laboratory settings (Grundgeiger, Sanderson, MacDougall, & Venkatesh, 2010). In general, in regards to the effects of interruptions, laboratory-based experiments have shown interruptions to be associated with increases in cognitive processing time (Cellier & Eyerolle, 1992); memory loss and less accurate recall (Oulasvirta & Saariluoma, 2004); impaired decision-making processes (Speier, Valacich, &

Vessey, 1999); and breaks in concentration (Altmann & Trafton, 2004). Interruptions can have a negative effect on primary task completion, the time taken to re-orient and restart a primary task after interruption, decision-making processes, and can increase error (Li, Magrabi, & Coiera, 2012). At the same time, interruptions can sometimes result in faster primary task completion (Li et al., 2012). This effect is assumed to be the result of a coping mechanism wherein individuals tend to work faster on a primary task after being interrupted in order to make up the lost time on the interruption (Trafton & Monk, 2007). As a result, although the primary task may be completed faster than if uninterrupted, the individual tends to perceive increased workload and stress (Li et al., 2012).

In regards to specific variables that influence the effects of interruptions, Li and colleagues (2012) reviewed 63 experimental lab-based studies to identify variables most important to the deleterious effects of interruptions: primary task complexity, practice/experience, interruption position, interruption handling strategies, interruption similarity, interruption modality, and working memory load. Table 1 summarizes these variables.

Section II: Interruptions in Health Care

Empirical Studies of Interruptions in Health Care

Given the evidence for adverse effects of interruptions in the laboratory setting, an assumed preponderance of interruptions in the health care setting has emerged. This is likely because the deleterious effects of interruptions may have consequences more dire in highly complex settings such as health care when compared to other settings. For example, interruptions occurring during preflight checklists have been considered the culprit for multiple aviation crashes (Trafton & Monk, 2007). Similarly, life-or-death outcomes can be the results of

Table 1

Summary of Li et al. (2012) Findings From Experimental Interruption Studies

Variable	Relationship to effect of interruption
Primary task complexity	As complexity of the primary task and interruption increases, so does the disruptiveness, or the degree to which interruptions consume time and increase error, of the interruption.
Practice/experience	Experience can counter the disruptiveness of complex interruptions. Experience dampens disruptive effects of an interruption that is similar to the primary task. Practice responding to interruptions is beneficial. Prior knowledge of an interruption may not provide extra beneficial effects over practice.
Working memory load (workload of working memory demand)	Longer interruptions are associated with higher working memory load.
Interruptions position (where in the primary task the interruption occurs)	Control over interruption position or when/how to respond to an interruption may reduce disruption. The effect of an interruption has on working memory load varies by interruption position.
Interruption modality (cognitive mechanism such as sight or sound	Interruptions involving the same modalities as the primary task are particularly disruptive. Interruption to a different modality from the primary task impacts working memory load. Prior knowledge of an interruption's modality affects handling strategies.
Interruption-handling strategy	Interruption-handling strategies are affected by frequency of interruption and dependent on the modality, or cognitive mechanism, of a primary task.
Interruption similarity	Interruptions that involve a high working memory demand and are highly similar to the primary task impede task performance.

Adapted from "A Systemic Review of the Psychological Literature on Interruption and its Patient Safety Implications," by S.Y. Li, F. Margrabi, & E. Coierea, 2012, JAMIA, *19*(1), 6-12.

interruptions in health care. The complex, cognitive tasks involved in patient care often require providers' undivided attention (Rivera-Rodriguez & Karsh, 2010). Constantly shifting attentional focus from one task to another may prevent health care providers from formulating complete and coherent pictures of patients (Chisholm et al., 2001). Therefore, a growing body of literature has begun examining the effects of interruptions, specifically within the health care setting, to address this issue.

In 2003, the Agency for Healthcare Research Quality published a report making the specific recommendation that "systems to reduce interruptions and distractions will likely reduce the incidence of medical errors" (Hickam et al., 2003). Since then, five systematic reviews of literature involving interruptions in health care have been published. Grundgeiger and Sanderson (2009) reviewed interruptions in critical care and medication dispensing settings in order to determine whether a relationship between interruptions and adverse events has been shown in empirical literature. Biron, Loiselle, and Lavoie-Tremblay (2009) also reviewed work regarding interruptions during medication administration, but focused on the work of nurses specifically. Rivera-Rodriguez and Karsh (2010) reviewed literature on interruptions in health care to determine the state-of-the-science and identify gaps in the research. Hopkinson and Jennings (2013) conducted an updated and more focused state-of-the-science review by searching more databases than Rivera-Rodriguez and Karsh and by including only studies involving nurses. Finally, Raban and Westbrook (2014) reviewed findings on the effectiveness of interventions to reduce interruptions and errors during medication administration.

Collectively, these reviews synthesize the results of approximately 75 nonduplicated studies related to interruptions in health care. Of those articles, 12 focused solely on communication patterns in the operating room or could not be accessed in full text, and were

thus excluded. I identified an additional five studies through key word searches, forward reference searching, and citation searches. Thus, a total of 68 articles reviewed for this dissertation.

In the remainder of this section, I further explore the state-of-the-science for the reviewed empirical studies of interruptions in health care by describing, when reported: how interruptions were defined, the design and data collection methods used, and the characteristics of interruptions studied to include the specific health care setting in which the interruptions occurred, study participants, the interrupted patient care process, frequency and duration of interruptions, and the primary and secondary tasks involved in the interruption. The remaining sections of this chapter outline three factors related to interruptions in the health care setting: antecedents of interruptions, consequences of interruptions, and efforts to mitigate the effects of interruptions.

Defining Interruptions

As previously described, interruptions at work have been interpreted and thus defined in different ways. About one-third of the health care studies did not provide an explicit definition of interruptions. Those that did, or used a similar term (such as distraction, disruption, or break-in task) varied in how they defined the term. Several studies considered interruptions as communication events only (Alvarez & Coiera, 2005; Coiera, Jayasuriya, Hardy, Bannan, & Thorpe, 2002; Edwards et al., 2009; Fairbanks, Bisantz, & Sunm, 2007; Sevdalis, Healey, & Vincent, 2007; Spencer, Coiera, & Logan, 2004). In these studies, interruptions were conceptualized as events that disrupted a communication stream.

The remaining studies considered interruptions as events that impeded or potentially impeded the completion of a task. These studies tend to conceptualize interruptions as

unexpected events that detract cognitive focus from a primary task, consistent with Jett and George's (2003) interruption categories of distractions (i.e., psychological response to an internal or external stimulus observable to others) and intrusions (i.e., the cessation of a task in response to the external stimulus (Hopkinson & Jennings, 2013; Li et al., 2012). While some studies considered any off-task attentional demand to be an interruption (or synonymous term) regardless of the subject's response, others explicitly differentiated between distractions and intrusions.

Unfortunately, the terminology used to make this differentiation was rarely consistent with Jett and George's (2003) taxonomy. For example, many authors used the term distraction consistent with their taxonomy, but used the term interruption to reflect an intrusion (Flynn, Barker, Pepper, Bates, & Mikeal, 2002; Grundgeiger et al., 2010; Healey, Sevdalis, & Vincent, 2006; Relihan, O'Brien, O'Hara, & Silke, 2010; Scott-Cawiezell et al., 2007; Sevdalis et al., 2007). Conversely, many authors used the term interruptions to reflect distractions and introduced the term break-in task to describe intrusions (Chisholm, Collison, Nelson, & Cordell, 2000; Chisholm et al., 2001; France et al., 2005). Three studies additionally utilized the term multitasking to reflect a response to an interruptive event that involves completing tasks in parallel rather than switching from one to another (Kalisch & Aebersold, 2010; Westbrook, Ampt, Kearney, & Rob, 2008; Westbrook, Duffield, Li, & Creswick, 2011). Only three of the studies used terminology completely consistent with Jett and George's (2003) taxonomy (Hall et al., 2010; McGillis Hall et al., 2010; McGillis Hall, Pedersen, & Fairley, 2010).

Study Design

A variety of research designs have been used to study interruptions in the health care setting. Table A1 in Appendix A provides a summary of the studies, their design, data collection

methods, and statistical analysis. Nonexperimental designs using simple descriptive statistics to quantify interruptions and their characteristics predominated, followed by eight quasi-experimental studies wherein an intervention was introduced to reduce interruptions. Fifteen studies used a mixed-methods approach, combining the quantitative information about interruptions with qualitative data from surveys, interviews, and focus groups. Three of the studies were purely qualitative (Hedberg & Larsson, 2004; Manias, Botti, & Bucknall, 2002; Tang, Sheu, Yu, Wei, & Chen, 2007).

In regards to developing an approach for studying interruptions in health care, few of the reviewed studies used a guiding theory to motivate their approach for studying interruptions (Grundgeiger & Sanderson, 2009; Hopkinson & Jennings, 2013). Only four studies explicitly referenced any guiding theoretical framework (Ebright, Patterson, Chalko, & Render, 2003; Grundgeiger et al., 2010; McGillis, Pederson, 2010; McGillis Ferguson-Pare, 2003; Pape, 2003).

Interruptions Characteristics

A large majority of studies take an exploratory approach, describing the frequency and nature of interruptions in the health care setting, defining frequency of interruptions according to the number of interruptions that occurred during the nurse's entire shift. According to the reviewed studies, interruptions in the health care setting are frequent and take on a variety of forms. The reviewed studies most often reported the following characteristics of interruptions: where the interruptions took place (i.e., the specific health care settings); whose work was impacted by interruptions (i.e., study participants); patient care processes affected by interruptions; and the frequency or rate of interruptions. Several studies also reported the tasks being interrupted (i.e., primary task) and the interrupting task (i.e., secondary task), although not all studies referred to these features of the interruption process using Trafton and Monk's (2007)

primary and secondary task verbiage. These characteristics of interruptions in the health care setting are described next.

Health care settings. Interruptions in health care have been examined in a variety of specific settings. The vast majority of studies have been conducted in the inpatient hospital setting (n = 41) followed by emergency departments (n = 13), and operating rooms or surgical suites (n = 7). Two studies were conducted in an outpatient/medical office setting (Dearden, Smithers, & Thapar, 1996; Rhoades, McFarland, Finch, & Johnson, 2001). One study was conducted in a nursing home (Scott Cawiezell et al., 2007). One study compared physician interruptions in emergency department versus primary care settings (Chisholm et al., 2000). One study was conducted in a simulated operating room environment with scripted interruptions introduced into the setting (Liu, Grundgeiger, Sanderson, Jenkins, & Leane, 2009). Three studies did not specify the health care setting, but indicated that participants worked in a variety of settings. Within the hospital setting, studies took place across multiple hospitals, on multiple units within a single hospital, or on multiple units across multiple hospitals. Table A2 in Appendix A notes the number of hospitals and units within each hospital when specified in a study.

Participants [3]. No health care professionals are exempt from interruptions as shown by the variety of health care professionals represented in the reviewed studies. Studies taking place within the hospital setting almost always included nurses as participants, with only three studies focusing solely on physicians (Westbrook et al., 2010; Westbrook et al., 2011) or pharmacy personnel (Flynn et al., 1999).

[3] For some studies, the providers constituted the sample make-up. Other studies used hours of observations or specific care processes as the sampling frame.

Patient care process. Most studies (n = 40) considered interruptions throughout multiple patient care processes when observing or collecting information. Some studies, however, focused on specific patient care processes. When doing so, the majority of studies focused on interruptions during medication-related activities (n = 17), followed by surgical or medical procedures (n = 6). The remaining studies focused specifically on pain management (Manias et al., 2002), emergency department triage (Lyons, Brown, & Wears, 2007), and computer order entry (Collins, Currie, Patel, Bakken, & Cimino, 2007).

Frequency and duration. Frequency of interruptions varied widely. Some studies reported only the total number of interruptions counted (e.g., Chisholm et al., 2000) or percentage of tasks that were interrupted (e.g., Anthony et al., 2010; Hillsden & Fenton, 2006). Other studies reported interruptions per medication pass or medication rounds (e.g., Elganzouri, Standish, & Androwich, 2009; Palese, Sartor, Costaperaria, & Bresadola, 2009). Most studies reported frequency of interruptions and hours of observations (n = 37). For these studies interruption rates were either explicitly provided by the authors, or could be calculated by this researcher by dividing the total number of interruptions by the total number of hours observed.

In past reviews, researchers have pooled data from multiple studies to estimate an average of 6.7 interruptions per hour (Biron et al., 2009). However, due to the many different ways researchers have defined interruptions, it is difficult to compare interruption frequency or rate across studies. For example, Grundgeiger and colleagues (2010) found that nurses were interrupted (defined as a "visual or auditory event that observably captured the attention of the participant and delivered some information" (p. 322) as often as 20.8 times per hour on average. Whereas, Coiera and Tombs (1998) measured interruptions as pages and telephone calls only and found nurses to experience an average of 1.4 interruptions per hour. It is important to note that

within an article the frequency of interruptions sometimes differed by pre- and post-intervention study periods, by providers. One study even used different definitions by different data collectors (Potter et al., 2005).

Duration of interruptions were reported less often (n = 16). In many of the studies, average interruption duration was most often reported as lasting less than or approximately equal to one minute (n = 8). However, many of the studies reported much lengthier interruption durations. For example, Palese and colleagues (2009) reported durations of 10.48 minutes on average. Spencer and colleagues (2004) found interruptions to last as long as almost 32 minutes on average. Differences in interruption definition as well as the highly variable environments of health care settings likely account for these differences.

Primary and secondary tasks. Interruptions have been further characterized according to their source (see Empirical Studies of Antecedents of Interruptions below), primary task characteristics (n = 20); secondary task characteristics (n = 22); and much less often according to their location (n = 6); and the specific context of the interruption (e.g., communication interruptions to convey clinical information related to patients, request orders, or offer help to other care providers (n= 16). Table A3 in Appendix A summarizes primary and secondary tasks when provided by the reviewed articles.

Primary task characteristics describe the activities being performed when interrupted (Biron et al., 2009). The primary tasks most frequently interrupted in the reviewed studies were patient care activities (direct and indirect) followed by medication-related tasks, communication, and documentation. Studies quantifying the frequency of primary task characteristics have shown mixed results. For example, one study found that nurses are interrupted most commonly when they are communicating, followed by documentation, and medication administration

(Kalisch & Aebersold, 2010). Hedberg and Larson (2004) conversely found that nurses are most often interrupted during patient care and medication administration.

Secondary task characteristics describe the interrupting task or what the health care professional is being asked to do (Biron et al., 2009). Secondary tasks can arise in many ways. For example, other care professionals and patients may make requests that interrupt the primary task. Operational failures (consistent with Jett and George's [2003] interruptions categorization of discrepancy) may interrupt a primary task when equipment malfunctions or cannot be found (Tucker, 2004, Tucker & Spear, 2006). Tasks may also be interrupted when a provider self-initiates the cessation of one task to attend to another. For example, a nurse may be in transit to retrieve a medication when he/she remembers that he/she first planned to finish some documentation. The secondary tasks most frequently reported in the reviewed studies were communication and patient care tasks. Less frequently mentioned secondary tasks included operational failures (such as waiting for and seeking out equipment), documentation, and medication-related tasks. Similar to primary tasks, few studies have quantified secondary tasks. One study found that patient care constitutes the bulk of secondary tasks for nurses (Spencer et al., 2004).

Empirical Studies of Antecedents of Interruptions

In exploring the nature of interruptions in the health care setting, several studies described sources of the interruptions (e.g., telephone, page, other staff, and equipment alarm); consequences of interruptions in the health care setting; and the actions taken by health care providers when responding to or managing interruptions (e.g., continue primary task before responding to interruption, multitasking, or immediately switching from the primary task to the secondary task). This section focuses on antecedents or sources of interruptions. The remaining

sections of this review focuses on the consequences of interruptions found in the empirical studies of interruptions in the health care setting, as well as efforts taken to manage interruptions and their effects.

When sources or causes of interruptions were reported in articles (n = 47), there was frequent variation across authors in how they grouped their findings. For example, some authors considered sources to be the event most proximal to the interruption. These proximal sources included face-to-face communications, telephones, and pagers. Others considered the initiator of the proximal event to be the source, such as patients, other health care team members, and environmental noises. Studies have also considered whether the interruptive stimuli were external or internal (i.e., self-initiated).

Table A4 in Appendix A organizes the 47 studies reporting interruption sources. Sources are organized by both proximal event and interruption initiator under the following categories: communication, equipment, environment, and self-initiated. Non face-to-face communication sources include pages, telephone calls, call-bells, lights and other communicative devices. Communication sources are then differentiated according to communication events from other care team members, patients, and family/visitors. Equipment sources are differentiated according to equipment alarms that require response (such as patient monitoring devices), other nonspecified equipment sources, and operational failures wherein equipment or other supplies are missing. Environmental sources include loud noises or conversations.

Many of the studies quantified frequency of interruption sources. In terms of sources of interruptions to nurses specifically, one study found that nurses were most frequently interrupted by patients, followed by other nurses, assistive personnel, and physicians (Kalisch & Aebersold,

2010). These findings are consistent with Lyons et al. (2007) which also found patients/family and other staff to most frequently interrupt nurses.

Empirical Studies of Consequences of Interruptions

While studies have qualitatively shown that nurses and other care providers perceive interruptions to cause medical error (Biron, Loiselle, & Lavoie-Tremblay, 2009; Elfering, Grebner, & Dudan, 2011; Hand & Barber, 2000), few studies have quantitatively examined this relationship. Most studies sought only to describe interruptions. Those studies that posited that interruptions are linked to medical error were based on extrapolation of findings from laboratory studies (Grundgeiger et al., 2010). Very few studies examine the explicit relationship of interruptions to performance errors (e.g., forgetting to sign a medical record), medical errors (i.e., errors impacting patient outcomes), or other outcomes such as provider well-being. The few studies reporting performance and well-being outcomes are next described.

Performance. The 11 studies examining performance errors as functions of interruptions in the health care setting yield mixed results. For example, some descriptive studies showed that no errors occurred as a result of interruptions (Hillel & Vicente, 2003; Potter et al., 2005). Similarly, a study of nurses found that errors were no more common when nurses were interrupted or when they multitasked than when the nurses were focused on a single task without interruption (Kalisch & Aebersold, 2010).

Conversely, McGillis Hall, and colleagues used three descriptive studies to classify outcomes of interruptions as either potentially negative (i.e., events that could result in delays and patient care or in the loss of nurse's focus); or potentially positive (i.e., events that improved safety, accuracy, or the patient's condition) effects on patient safety (McGillis Hall, Pedersen, & Fairley, 2010; McGillis Hall, Ferguson-Pare, et. al., 2010; Hall, Pedersen, et. al., 2010). These

researchers found that the effects of interruptions were more often potentially negative than positive. However, it was not clear how McGillis Hall and colleagues determined the potential outcomes or in which category to place them.

Studies analyzing the effects of interruptions through methods more rigorous than descriptive statistics yield less ambiguous results. Grundgeiger et al. (2010) used multiple regression analysis to find that interruptions increase the time that it takes to return to primary tasks after experiencing an interruption. One study found that when tasks were interrupted, 18.8% were not completed, compared with 1.5% of uninterrupted tasks (Westbrook, Coira et al., 2010). In that same study, 98.2 % of physicians failed to return to interrupted tasks. An experimental study in a simulated operating room found that physicians failed to perform bedside perfusion checks when immediately engaging with the interruption; whereas, those who rejected or deferred the interruption all noted and remedied the omitted task (Liu et al., 2009).

The single study using inferential statistics to examine the relationship between interruptions and medication errors found a direct link. Westbrook, Woods et al. (2010) found interruptions to be associated with a 12.7% increase in clinical errors (i.e., when the medication administered differed in some aspect from its original order), and a 12.1% increase in procedural errors (e.g., failure to use of aseptic technique, failure to check patient identification). They estimated that the risk of a major clinical error occurring in a single drug administration doubled from 2.3% (in the presence of zero interruptions) to 4.7% (in the presence of 4 interruptions). The clinical errors occurred independently of hospital and nurse clinical experience (Westbrook, Woods et al., 2010).

Well-Being. Research in well-being has presented a multifaceted and broad definition of well-being (Dodge, Daly, Huyton, & Sanders, 2012). For the purpose of this study, well-being

focuses on three distinct dimensions: the balance of positive and negative affect (Heady, 2006; Heady, Homstrong, & Wearing, 1984a, 1984b;) and stress (Heady & Wearing, 1991). The literature review conducted for this study revealed that there is a dearth of literature examining the relationship between interruptions and care provider well-being. Three studies reported results related to the negative experience of interruptions. One nonexperimental, descriptive study reported that "nurses who were interrupted occasionally exhibited frustration from the increased workload and mental demand imposed by the interruption" (Hillel & Vicente, 2003, p. 1445).

However, this observation regarding the nurses' emotions was made by the authors, and was not explicitly investigated. A second descriptive, qualitative study showed that nurses may view unnecessary interruptions as frustrating (Tucker, 2004). The third nonexperimental study used step-wise linear multiple regression analysis to examine the association between nursing job characteristics (stressors and resources-job control) and cognitive function. It implicitly considered interruptions to be stressors but did not explicitly examine whether stress actually resulted from interruptions (Elfering et al., 2011). The present study seeks to fill this gap by directly testing the relationship between interruptions and perceived stress, positive affect, and negative affect.

Empirical Studies of Mitigators of Interruptions

Several studies examined efforts taken to manage interruptions and their effects. Eleven studies were designed to investigate the effects of interventions to minimize the frequency of interruptions. Because MAEs have been considered a consequence of interruptions, researchers have studied approaches for reducing nurse distraction during the medication administration process (Pape et al., 2003; Relihan et al., 2010). The interventions to modify the behaviors of

nurses and others during the medication administration process (such as the implementation of quiet zones, signage to indicate that the nurse should not be interrupted, checklists, and apparel), as well as changes to medication distribution systems, are described next.

One quasi-experimental study used analysis of variance and bivariate linear regression to test two interventions: (a) a standardized checklist protocol, and (b) a standardized checklist protocol with a visual symbol worn by nurses to indicate medication work underway (Pape et al., 2003). Comparing findings with a control group undergoing no intervention, both interventions were effective in significantly reducing interruptions (Pape et al., 2003). Similarly, three quasi-experimental uncontrolled, pre- and posttest studies testing the implementation of behavior modification interventions also found significant reductions in interruptions postintervention (Anthony et al., 2010; Pape et al., 2005; Relihan et al., 2010).

Three studies compared frequency of interruptions among different medication distribution systems. Two studies reported fewer interruptions when medications were stored in decentralized areas when compared to central drug storage (Bennett, Harper-Femson, Tone, & Rajmohamed, 2006; Popescur, Currey, & Botti, 2011). Another study identified differences in types of interruptions before and after the implementation of medication barcode scanners (Stamp & Willis, 2010). They found that interruptions during medication administration were often related to issues with medication records and accessing information prior to the implementation. After the implementation, interruptions were often related to technology errors such as issues scanning medication.

One study combined behavior modification (red apparel and education) and medication distribution changes (dedicated room for medication preparation) in their intervention (Tomietto, Sartor, Mazzocoli, & Palese, 2012). The researchers found interruptions increased in their

frequency, but decreased in length and had different causes post implementation. Specifically, the number of interruptions increased by 11.5%. Interruptions initiated by patients were reduced; however, interruptions initiated by other staff members increased.

One study used descriptive frequencies to analyze the impact of the interventions on interruptions during medication preparation and administration (Freeman, McKee, Lee-Lehner, & Pesenecker, 2013). The authors report that a bundle of interventions (education, signs, vests, quiet zone, diversion strategies and process strategies) reduced the average number of interruptions during medication administration by 2.11 interruptions per encounter and decreased reported medication errors by a total of 28 incidents. However, the sample size was not large enough to determine statistical significance; nor was the relationship of interruptions to errors quantitatively or qualitatively examined.

Finally, several studies examining interruptions in the health care setting used the experience level of nurses as a participant inclusion criteria (e.g., Ebright et al., 2003; Grundgeiger et al., 2010; Kalisch & Aebersold, 2010). Although not explicitly stated, this inclusion criteria is likely related to the assumption that as individuals gain expertise in their work, they become less susceptible to the effects of interruptions (Li et al., 2012; Trafton & Monk, 2007). Characteristics additional to nurse experience-level may inform how nurses respond to interruptions. Only one study considered such characteristics. Elfering and colleagues (2011) considered conscientiousness and neuroticism as control variables for predicting cognitive failure resulting from interruptions. Through statistical analysis, they found that neuroticism was positively correlated with cognitive failure, but was not significant in their regression model. Conscientiousness was negatively correlated with cognitive failure and negatively predicted in the regression model.

Section III: Conclusion

In summary, this review of the empirical literature examining interruptions in the health care setting reveals several gaps. While studies have asserted that interruptions result in adverse outcomes, the evidence of the extent to which this actually occurs in health care is considerably lacking. This lack of evidence appears to stem from limitations to previous work in the area of study design to include inadequate statistical methods and lack of motivating theory. Additionally, the likelihood for certain antecedents to predict interruptions or for medical errors to directly result from interruptions rests on several assumptions not often explicitly examined in the reviewed literature. As a result significant limitations relate to the manner in which antecedents, consequences, and potential mitigators of the effects of interruptions have been studied. This conclusion therefore summarizes these limitations and explains how this study will fill them.

Design

Several design limitations exist in empirical health care literature in terms of motivating theory and inadequate statistical methods.

Lack of theory. Lack of theory presents a major weakness in most of the interruption literature. A theory driven approach to understanding the effects of interruptions is critical to discerning the mechanisms through which interruptions affect employee performance and well-being, and what can ultimately be done to mitigate their negative outcomes. Moreover, given that the assumed implications of interruptions are largely based on the effect that interruptions have on cognitive function, theoretical frameworks should employ psychological constructs. Only one of the 68 reviewed studies operationalized psychological constructs in their examination of interruptions (Grundgiger et al., 2010). This study seeks to fill this gap by using

constructs from organizational psychology to examine specific mechanisms through which interruptions take their effect, including how they take their effect over time, as well as how specific intrapersonal resources that may protect against or mitigate those effects.

Statistical methods. There exists a preponderance of descriptive studies rather than those that employ multivariate statistical modeling. Very few studies examine the inferential relationship between interruptions and their effects. Methodologically, most studies of patient care processes considered the nurse's entire shift as whole. This empirical modeling does not allow for clustering of interrupted events within nurses which may lead to biased effect estimates and potentially leading to Type I error (Raudenbush & Bryk, 2002).

Moreover, nurse's work in the acute care setting occurs in sequential episodes, wherein nurses enact a number of care activities while providing care for one patient before moving onto the next patient (Potter et al., 2005). Figure 3 displays an example of the sequence of steps conducted by one nurse in an inpatient setting while working with five patients assigned to her care during a 10-hour observation period. In this figure, numbers placed along the top horizontal axis record times of observations; numbers placed along the left vertical axis record patient room numbers; vertical arrows across time span demonstrate shifts between patients as the nurse engages in different stages of the nursing care process; and numbers along the bottom horizontal axis (with arrows) record interruptions. The graphic reveals how in the beginning of the shift the nurse engages in various stages of the nurse care process (depicted by the numbers

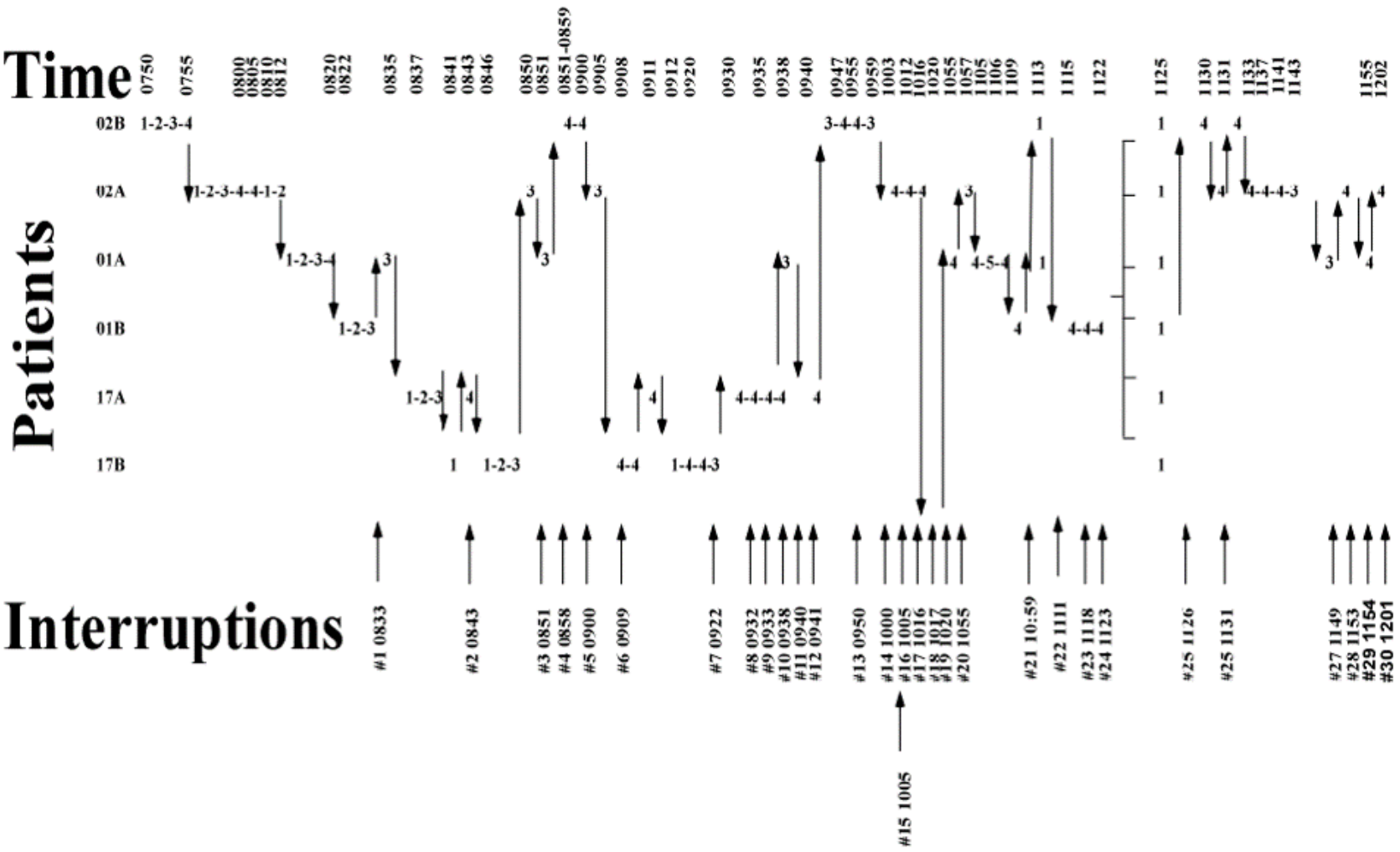


Figure 3. Graphic representation of nurse's work.

1-4) for a patient in room 02B before moving on to provide care to the patient in room 02A, and so on.

It must be acknowledged that such processes are not always perfectly linear, and interruptions may influence this nonlinearity. For example, at approximately 8:30 a.m., the nurse leaves room 17A to approach 17B. It appears that she is interrupted during her work in 17B, returns to room 17A to provide additional care to its patient, before returning to complete the care of the patient in room 17B. Nevertheless, the care activities occur within sequential episodes of care for each patient, even in the face of multitasking or interruptions.

This study will examine effects of interruptions by conceptualizing nurse care as being provided in sequential care episodes. Employing a sequential episodic conceptualization is ideal for studying nursing care because it reflects the reality of how nursing care is provided. Such an approach will result in enhanced statistical analysis as well as match complex statistical modeling with complex theory.

Predictive Antecedents

While sources of individual interruptions have been extensively described, research is needed to consider additional antecedents, and possibly predictors, of interruptions. In their 2010 review of interruptions and distractions in health care, Rivera-Rodriquez and Karsh recommended that future research consider "how to design non-purposeful external interruptions out of the system to the greatest extent possible" (p. 6). In the general interruption literature, few studies have considered the role of the physical configuration of work spaces in interruptions. Rouncefield, Hughes, Rodden, and Viller (1994) note that physical arrangements of workspaces influence workflows in such a way that facilitate the shared awareness of work flow patterns, which may influence frequency of interruptions. Chong and Siino (2006) found that in a

software programming environment the physical work space may influence how workers respond to interruptions. Additionally, high spatial density (i.e., crowding) of workspaces can affect one's abilities to complete tasks because one has less control over interactions with others and are thus more likely to be interrupted and distracted (May, Oldham, & Rathert, 2005; Oldham & Rotchford, 1983). Beyond these, there is a dearth of literature examining this relationship.

In regards to the inpatient setting, patient room type has been implicated as a possible predictor of interruptions. Freeman and colleagues (2013) assert that multiple-occupancy patient rooms lend an opportunity for more interruption than do SO patient rooms. In multiple-occupancy rooms, patients, their families, visitors, and the equipment required for their care are housed within the shame spared space. Given that sources of interruptions in the health care setting commonly come from equipment, the requests of patients, and the requests of patients' families and visitors; and given that multiple-occupancy rooms house an excess number of these sources when compared to SO, it is possible that the frequency of interruptions may vary by room type. A care provider may experience more interruptions when providing care in a multiple-occupancy room than when providing care in an SO room type. This relationship, having not been studied as a possible predictor of interruptions in the health care setting, will be examined in the present study.

Consequence Examination

Few studies have directly examined the relationship between interruptions and their assumed effects in the health care setting. Studies in the health care setting have based assumptions about interruptions and their effects on laboratory studies. Yet extrapolation of laboratory findings to the health care setting may be an overextension. Laboratory studies

appear to be limited to unaided individuals solving unfamiliar low-risk tasks (Grundgeiger et al., 2010). Health care presents a vastly different environment. In the health care setting, individuals work with team members on tasks that may or may not be familiar to them in the face of a great deal of uncertainty. Thus, a direct examination of the effects of interruptions in the health care setting is needed.

Additionally, each study reviewed focused on circumstances immediately surrounding individual interruptions. No studies examined the effects of interruptions over time during the work day. However, recent research indicates that events occurring throughout the work day can affect employee performance over time (Beal et al., 2005).

Finally, the effects of interruptions on well-being have rarely been studied. Yet one way in which interruptions take their effect appears to be through individual well-being. Frequent interruptions and inability to complete tasks have been implicated as a critical factor in work stress (Kirmeyer, 1988). This effect is likely related to the emotional experience of task accomplishment. The ability to accomplish work tasks, or achieve work goals, has been associated with pleasurable feelings in the employee, especially when the work goals are personally important to the employee (Harris, Daniels, & Briner, 2003). Nurses, specifically, tend to experience more positive emotions when they are able to accomplish tasks as planned, and more negative emotions when they are not (Carton & Aiello, 2009; Gabriel, Diefendorff, & Erickson, 2011; Jett & George, 2003; Kirmeyer, 1988). Thus, a direct examination of the effects of interruptions on the health care professional well-being is needed.

Interruption Mitigation

The current evidence for interventions to reduce interruptions, and their effectiveness in reducing medical errors, is weak (Raban & Westbrook, 2014). The mixed results of studies

examining interventions to reduce medication errors caused by interruptions that additional research is needed to better understand this complex relationship (Raban & Westbrook, 2014). The majority of efforts to mitigate the effects of interruptions were designed to minimize the frequency of interruptions. As previously described in Chapter 1, interruptions may be necessary for the successful function of a complex health care delivery system. Thus a simple approach to eliminate interruptions may not be meaningful, and may even be harmful (Grundgeiger & Sanderson, 2009; Rivera-Rodriguez & Karsh, 2010). A thorough and more holistic consideration of interruptions must closely examine the processes through which interruptions take their effect, especially in instances when frequency of interruptions cannot be reduced.

Additionally, studies involving interventions to reduce interruptions have involved the addition of technology. These studies often fail to consider additional burden created by the intended solution (Boehm-Davis & Remington, 2009). For example, the enlisting of new protocols and checklists require that the new approaches be learned and time made for their use. For all of these reasons, additional research is needed to understand how interruptions in the health care setting may be successfully mitigated rather than eliminated (Grundgeiger & Sanderson, 2009; Institute of Medicine, 2004).

The reviewed studies did not examine psychological mechanisms involved in individual response to interruptions. As described in Chapter 1, in health care, multiple, complex human and organizational factors come together in a system to affect interdependent interactions (Institute of Medicine, 2000). Organizational factors related to interruptions have been studied extensively in terms of sources and types of interruptions (see Table A4 in Appendix A). Yet, few studies have focused on individual or psychological characteristics of nurses that may reduce their vulnerability to interruptions.

A systems approach to medical error considers individuals as having defenses, or resources, which can be deployed to avert errors or mitigate their effects (Reason, 2000). In their review of the role of interruptions in the workplace, Jett and George (2003) highlight that distractions tend to result in mediocre performance when the employee has particular traits that make him or her vulnerable or sensitive to distractions. This suggests that individuals may have particular characteristics that make them less vulnerable to (i.e., buffer against) the effects of interruptions. Such characteristics have been conceptualized as psychological resources that individuals have within themselves, hereafter referred to as intrapersonal resources (Hobfoll, 1989). The present study examines the possibility for certain nurse characteristics to act as resources that may mitigate the deleterious effects of interruptions. The implications of this study may offer insight as to whether some nurses are better equipped with certain intrapersonal resources so that they perform better in the face of interruptions.

Summary

This study will fill the following gaps in the literature:

1. Use a systems approach to understanding interruptions in health care by examining both organizational and individual factors that can lead to medical error.
2. Employ theory from industrial-organizational psychology to develop a conceptual framework.
3. Employ a statistical model that appropriately matches sophisticated empirical modeling to the reality of nurses' work organization.
4. Consider the role of patient room type as a possible predictive antecedent of frequency of interruptions.
5. Directly examine interruptions effect on nurse performance and well-being.

6. Examine the effects of interruptions over time throughout the work day.
7. Posit psychological intrapersonal resources as potential mitigators of the negative effects of interruptions.

Overview of Remaining Chapters

Chapter 3 will present the theoretical underpinning for a series of hypotheses that develop a multilevel conceptual model which considers how individual nurse level characteristics interact with patient care episode level events to effect nurse performance and well-being outcomes over the course of a nursing shift. Chapter 4 will outline the study methods, explaining how this conceptualization of nurses' work also allows for a statistically appropriate a multilevel model to account for the hierarchical nature of sequential patient care episodes nested within nurses. Chapter 5 will present the findings from the observational study. Finally, a discussion of the findings and their implications will follow in Chapter 6.

Chapter 3: Theoretical Framework

In Chapter 2, I reviewed findings from empirical studies of interruptions in the health care setting. Among others, I highlighted two major limitations: (a) the literature is largely atheoretical, and (b) studies fail to approach their subject matter from a perspective that considers both organizational and human characteristics in their conceptual frameworks. The current study fills both of these gaps by using Job Demands-Resources theory to provide an overarching theoretical framework for considering interruptions from an interactive perspective wherein organizational characteristics of the workplace interact with internal human characteristics (i.e., intrapersonal resources) to affect different performance and well-being outcomes (Bakker, Demerouti, & Euwema, 2005; Bakker, Demerouti, Taris, Schaufeli, & Schreurs, 2003).

Therefore, the purpose of this chapter is to construct a theoretical framework for the study using Job Demands-Resources (JD-R) theory as an overarching theory, supported by supplemental theories and constructs. Section I describes: (a) the primary constructs of JD-R theory, (b) the strengths of using JD-R theory in the present study, and (c) a conceptual model for this study motivated by JD-R theory. In sections II and III, hypotheses are generated from the conceptual model. Section II presents patient room type as an organizational characteristic that predicts interruptions and utilizes supplemental theories and constructs to hypothesize effects of interruptions. Section III presents three intrapersonal resources as human characteristics that interact with and buffer the effects of interruptions on nurse performance and

well-being. The chapter culminates in a summary and presents a complete conceptual model.

Section I: Job Demands-Resources Model

Job Demands-Resources categorizes different characteristics of work into two broad categories: job demands or job resources (illustrated in Figure 4). These are the primary constructs of JD-R theory. Jobs Demands-Resources theory suggests that an imbalance of these demands and resources leads to negative performance and well-being (Demerouti et al., 2001). In recent decades, the organizational literature has increasingly shown that one's job characteristics can have intense and wide-ranging effects on employee performance and well-being. For example, job demands, such as work pressure, can lead to exhaustion and interfere in home life (Demerouti, Bakker, & Bulters, 2004), as well as cause physiological damage (Vrijkotte, van Doornen, & de Geus, 2000). At the same time, the resources that employees have at the job, or bring within themselves to the job, have also been found to impact performance and well-being positively. For example, the job resource of social support at work has been linked to improved team functioning and mental health in employees (Heaney, Price, & Rafferty, 1995).

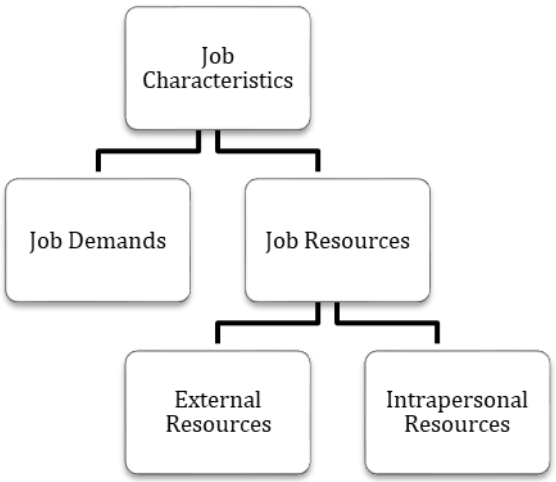


Figure 4. Job characteristics of JD-R model.

Job demands refer to "the physical, psychological, social, or organizational aspects of one's job that require sustained physical and/or psychological (cognitive and emotional) effort or skills" (Bakker & Demerouti, 2007, p. 312). Examples of job demands are high time pressures, demanding interactions with customers, and unfavorable physical work environments. Job demands are considered to lead to a depletion of employee energy, resulting in poor performance, well-being, burnout, and even reduced health (Bakker & Demerouti, 2007). They are thus associated with having physiological and/or psychological costs.

Conversely, job resources refer to the "physical, psychological, social, or organizational aspects of the job that may do any of the following: (a) help achieve work goals; (b) reduce job demands and their associated physiological and psychological costs; and/or (c) stimulate personal growth and development" (Bakker & Demerouti, 2007, p. 312). All job resources are typically considered to play a protective role in employee performance and well-being, and are considered instrumental in achieving work goals (Bakker & Demerouti, 2007). This study is particularly interested in those job resources that reduce job demands and their associated costs.

As previously mentioned, job resources can stem from within an individual, and are referred to as intrapersonal resources (Demerouti et al., 2001). Intrapersonal resources span a wide array of psychological states and traits which individuals may possess (Demerouti et al., 2001; Halbesleben, Neveu, Paustian-Underdahl, & Westman, 2014; Hobfoll, 1989). Of less interest to the present study are external resources. External resources include both organizational resources (such as job control, participatory decision making, and task variety) and social resources (such as support from colleagues and peer groups) (Demerouti et al., 2001).

Relationship of Job Demands and Resources

A major assumption of the JD-R model is that job stress develops when job demands are

high and when job resources are low. This effect has been conceptualized in previous studies, in one of two ways: (a) with job demands and resources having a unique (i.e., main) effect; or (b) with job demands and resources having an interactive effect. When conceptualized as main effects, high demand jobs have been found to exhaust employees' physical and mental energy, and low job resources have been found to undermine employee motivation (Bakker et al., 2005). Alternatively, when conceptualized as an interactive effect, job resources have been found to have a buffering or moderating effect, where the interaction of job resources with job demands reduces the deleterious effects of job demands (Bakker et al., 2003; Bakker et al., 2005). This interactive conceptualization is particularly helpful to organizations as it implies that employee performance and well-being may be maintained even when it is difficult to reduce or redesign job demands (Bakker et al., 2005; Bakker & Demerouti, 2007).

Strengths of JD-R in the Present Study

The JD-R interaction effect presents two important strengths for studying the effects of interruptions in health care. First, the JD-R interaction effect allows for the study of interruptions from a perspective of acute patient care as a system of interdependent organizational and human characteristics that interact to result in certain outcomes. Second, this interaction effect is important for better understanding how the job demands of interruptions negatively affect employee performance and well-being outcomes, and in turn, how those effects may be mitigated. As previously stated, job resources have the potential to buffer the damaging effects of high demand jobs. Thus, understanding the extent to which intrapersonal resources act as buffers can help identify mechanisms that might mitigate the negative effects of job demands.

Moreover, the successful mitigation of the effects of high job demands is dependent upon employing the appropriate job resources (Bakker et al., 2005; Bakker & Demerouti, 2007). The

JD-R model asserts that some resources are more relevant than others for facilitating the achievement of work goals in the face of specific job demands (Bakker et al., 2005; Bakker & Demerouti, 2007). In terms of intrapersonal resources, the buffering effects of intrapersonal resources have been shown to reduce the damaging consequences of high job demands by altering the perceptions and cognitions evoked by job demands, thus moderating one's responses during event appraisal processes (Kahn & Byosiere, 1992). In sum, the interactive conceptualization of JD-R helps to determine which intrapersonal resources may act as the best buffers against the particular job demand of interruptions.

Conceptual Model

Figure 5 presents a conceptual model, built on JD-R theory, to predict outcomes of room type, interruptions, and specific intrapersonal resources of nurses that buffer against interruptions' negative effects. This model conceptualizes interruptions as job demands. Consistent with JD-R theory, interruptions (acting as job demands) are proposed to have potential deleterious effects on nurse performance and well-being, and may be a function of the physical design of the nurse's work environment (i.e., patient room type) (Bakker & Demerouti, 2007). The model specifically posits that frequency of interruptions mediates the effect of room-type on the posited dependent variables. The dependent variables include measures of performance and well-being. In terms of performance, interruptions are posited to negatively affect task completion and medication administration errors (MAEs). In terms of well-being, interruptions are posited to negatively affect perceived stress and emotion states (specifically, experience of negative and positive affect).

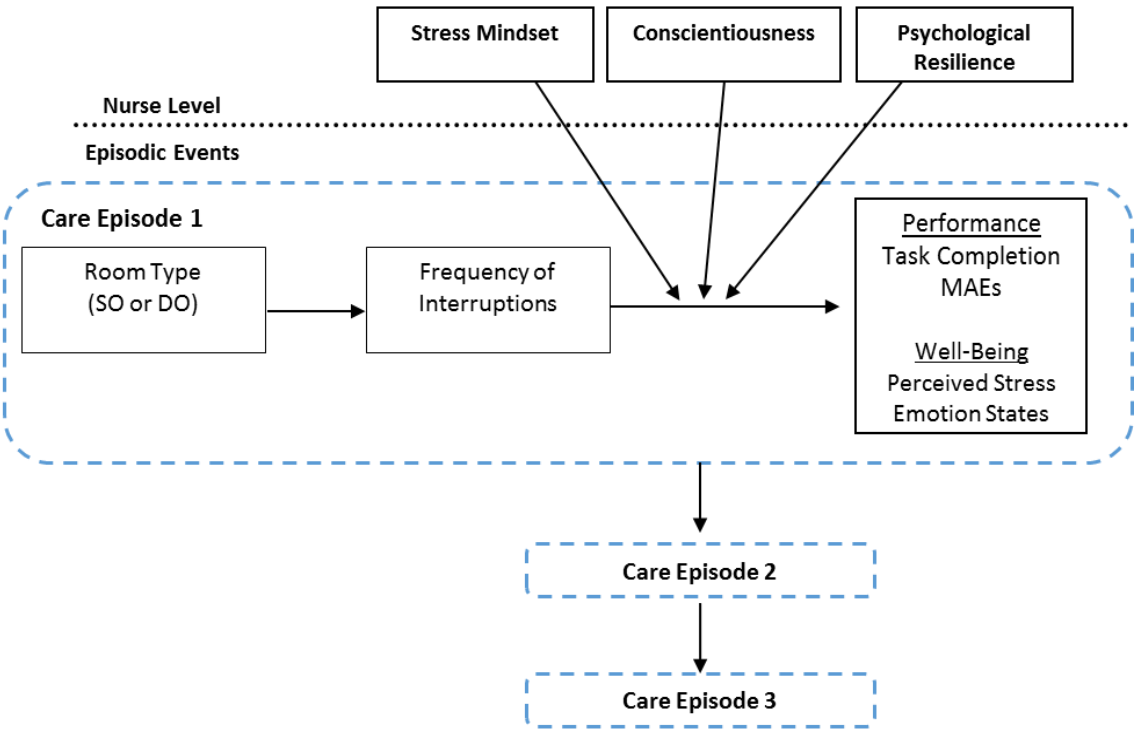


Figure 5. Conceptual model.

The model further conceptualizes intrapersonal resources as stress mindset, conscientiousness, and psychological resilience. Using the JD-R interaction effect, the model posits that nurses' intrapersonal resources interact with interruptions to buffer against their deleterious effects on the posited dependent variables (Bakker & Demerouti, 2007). Finally, the model conceptualizes nurse care as occurring in care episodes, wherein nurses enact a number of care activities while providing care to one patient before moving on to the next (see Section II: Downward Performance Spirals). The model posits that the deleterious effects of interruptions occurring during one nurse care episode will negatively affect the dependent variables of subsequent care episodes.

Section I of this chapter has outlined the primary constructs of JD-R theory and their relationship to one another, presented in a conceptual model. In sections II and III, hypotheses are generated from the conceptual model, with section II focusing on hypotheses related to

organizational characteristics, and section III focusing on human characteristics. These sections utilize supplemental theories to bolster their arguments. The chapter culminates in a summary and presents a complete conceptual model.

Building on JD-R in the Present Study

This study considers certain psychological processes that build on the JD-R model and explain the effects of interruptions. Supplemental theories and constructs are integrated throughout the conceptual framework to develop nine of the 10 hypotheses. These additional theories and constructs include: cognitive interference (Hirst & Kalmar, 1987; Wickens & Hollands, 2000), affective events theory, (Weiss & Cropanzano, 1996), and the episodic model of performance (Beal et al., 2005). The next two sections pull together the constructs of JD-R and the aforementioned supplemental theories to present an approach to understanding the effects of interruptions as well as how these effects may be mitigated. Together, these theories and constructs are used to discuss the theoretical underpinnings of how interruptions take their effect over time.

Section II operationalizes job demands (i.e., organizational characteristics) as interruptions, with patient room type acting as a predictive antecedent of the frequency of interruptions. It integrates the aforementioned supplemental theories to posit specific effects of interruptions. Section III demonstrates the interactive effect of JD-R. It posits three specific intrapersonal resources (i.e., human characteristics) that may buffer against the negative effects of interruptions.

Section II: Organizational Characteristics

Patient Room-Type

The JD-R model proposes that poorly designed work environments may create excessive psychological demands on the employee, resulting in high psychological cost for the individual (Bakker & Demerouti, 2007). For example, the configuration of a workspace might foster excessive background noises which can result in frustrated employees. Jett and George (2003) suggest that the physical design of the built environment may specifically foster interruptions when the configuration of work spaces brings people close together and increases the likelihood of unplanned encounters that interrupt work. The present study therefore considers DO) room-type to be a physical configuration that acts as a predictive antecedent of frequency of interruptions in the health care setting, which has not previously been studied extensively.

While disruption of patient care can occur in any health care setting, this study focuses on the inpatient setting, and more specifically room-type. Inpatient rooms can be designed for single or multiple patients to occupy during their hospitalization. When a room is occupied by multiple patients simultaneously, it is also occupied by the patients' visitors, care providers, and their medical equipment. This presence of excess people and equipment in DO rooms may lead to increased frequencies of interruptions when compared to SO rooms. Thus, I offer my first hypothesis:

H_1: Nurses providing care in DO rooms will experience more interruptions than when providing care in SO rooms.

Effects of Interruptions

Cognitive interference. The remainder of hypotheses in Section II will focus on how interruptions mediate the effects of room-type on nurses. A variable is considered a mediator if it transmits an indirect effect of the independent variable through to a dependent variable. According to JD-R poorly designed work environments such as room-type may create excessive psychological demands on the employee. Yet the physical design of the patient room cannot solely account for excess psychological demands. Rather, I hypothesize that frequency of interruptions acts as the specific job demand that is creating excessive psychological demands on employees. Specifically, I hypothesize that the indirect effect of room-type is transmitted through interruptions to result in impaired performance and well-being (Bakker & Demerouti, 2007).

A theoretical underpinning of the association of interruptions with psychological demands is that interruptions create cognitive interference. Cognitive interference is built on the concept of working memory (Wickens & Hollands, 2000). Working memory is the information storing part of one's cognitive function that retains new information until one no longer needs it. Cognitive interference is instigated by competing environmental stimuli and affects the cognitive processes of memory and focused attention (Jett & George, 2003). Interruptions create cognitive interference because they draw from the same working memory resources that are necessary to complete a task (Hirst & Kalmar, 1987; Wickens & Hollands, 2000). This is because information about the primary task has to be stored while new information resulting from the interference must be processed (Elfering, 2008).

In other words, interruptions direct attentional resources away from primary tasks. This attentional diversion contributes significantly to cognitive load, and can trigger cognitive failures

and lapses in attention and/or memory (Jett & George, 2003). In addition to the increased cognitive load of an interruption, interruptions may also result in the onset of additional tasks or activities for an individual to complete, compounding the effects on working memory load (Trafton & Monk, 2007). In turn, the cognitive interference combined with the additional tasks that interruptions create can lead individuals to fail to complete necessary primary tasks (Jett & George, 2003). Maintaining cognitive function has been found to be crucial for the safe completion of nurse tasks, and has been implicated in nurses' ability to prevent, intercept, and correct errors in patient care (Elfering, Grebner, & Dudan, 2011). Consistent with JD-R and supported by the notion of cognitive interference, I offer the next hypothesis:

H_2: Interruptions mediate the effect of room-type on task completion rate, where increased frequency of interruptions decreases task completion rate.

Nurses perform a variety of disparate and demanding care tasks, both directly and indirectly involved in patient care. An important care task for which nurses are predominantly responsible is the administration of medication (Koppel et al., 2005). When administering medication, nurses are not only responsible for physically administering the medication to the patient, but are also tasked with confirming that the medication has been dispensed in the correct dose, form, and timing, to the correct patient, and that no known contraindications for administering the medication exist (Hughes & Ortiz, 2005). When any one of these final checks in the medication administration process is incomplete or inaccurate, an MAE is said to have occurred (Allan & Barker, 1990).

The task of medication administration must be completed fully and accurately in order to avoid an MAE. Just as the cognitive interference created by interruptions can impede the accurate completion of any nurse task, the same can be assumed for the complex task of

medication administration. Thus, Hypothesis 3 emphasizes the critical nurse task of medication administration.

H_3: Interruptions mediate the effect of room-type on task MAEs, where increased frequency of interruptions increases rate of MAEs.

Affective events. As interrupted nurses realize that less time is available to accomplish tasks, they may perceive an impending inability to attain their work goals. Research has shown that inability to attain work goals or perceiving that one has failed a work task negatively relates to personal well-being (Harris et al., 2003; Lee & Ashforth, 1996; Maslach & Jackson, 1981). Additionally, nurses may feel frustration at having more responsibilities than the time allotted in which to do them (Jett & George, 2003; Trafton & Monk, 2007). Ultimately, in response to interruptions, nurses may feel a heightened sense of stress or negative emotion and a lower level of positive emotion (Jett & George, 2003). I therefore hypothesize:

H_4: Interruptions mediate the effect of room-type on perceived stress, where increased frequency of interruptions increases perceived stress.

H_5: Interruptions mediate the effect of room-type on positive affect, where increased frequency of interruptions decreases experience of positive affect.

H_6: Interruptions mediate the effect of room-type on negative affect, where increased frequency of interruptions increases experience of negative affect.

Downward Performance Spirals

While interruptions have the potential to affect nurse performance and well-being in the immediate moments surrounding an interruption, they may also affect nurses over time. This long lasting effect of interruptions occurs through the notion of performance episodes as described in Beal and colleagues' episodic model of performance. Similar to affective events

theory the episodic model of performance links emotional work experiences to work performance (Beal et al., 2005). The episodic model of performance conceptualizes the work day as being composed of sequential performance episodes. These performance episodes are defined as naturally segmented work episodes thematically organized around organizationally relevant goals or desired end states (Beal et al., 2005).

Whereas affective events theory asserts that specific events act as proximal causes of emotional responses, the episodic model of performance considers how these emotional experiences vary within the individual over the course of the entire work day (Beal et al., 2005). An underlying assumption of the episodic model of performance is that the extent of psychological demands imposed on an employee will likely vary within the sequential episodes of the work day. Moreover, events occurring in one episode can affect performance and well-being in subsequent episodes (Beal et al., 2005).

The episodic model of performance further asserts that performance is largely dependent on the intrapersonal resources individuals direct towards task accomplishment (Beal et al., 2005). These intrapersonal resources include individual skill level, task relevant knowledge, general cognitive ability, and other psychological resources. Psychological resources are a specific kind of intrapersonal resources that individuals use in their social relations and in how they organize, behave, and fit into the greater context of their work and social lives (Hobfoll, 2001).

In the case of interruptions, performance is expected to suffer to the extent that attention is diverted or fragmented (Schneider & Fisk, 1982; Speier et al., 1999). To combat interruptions, individuals must employ their self-regulation resources. Self-regulation is generally thought of as effortful attempts to alter or control one's behaviors or mental state (Baumeister, Schmeichel, & Vohs, 2007). Considered as an essential component to task accomplishment and work

performance, it is the process by which individuals determine what they will direct their broader intrapersonal resources toward (Locke & Latham, 1990). Interruptions demand that individuals employ their self-regulation resources because they create off-task attentional demands. These off-task attentional demands occupy additional cognitive resources that would otherwise be used to maintain performance during work-related activities (Jett & George, 2003).

Also, as previously noted, interruptions can create affective, or emotional, responses (Weiss & Cropanzano, 1996). It is important to note that emotional experiences carry equal weight to off-task attentional demands by leading employees to use time and cognitive effort to (a) appraise the event that caused the negative emotion, (b) ruminate on the event, and (c) have heightened further emotional arousal (Beal et al., 2005). Each step creates demands which shift attentional focus away from the primary or critical task at hand, and which require self-regulation resources to manage or control. In this way, emotional experiences have consequences that also demand the use of self-regulation resources.

The use of these self-regulation resources can be depleting to an individual over time (Muraven & Baumeister, 2000). Similar to muscle fatigue, as self-regulatory resources are used, their strength decreases. As their strength decreases, further self-regulation becomes more difficult. Renewal of these resources comes only with time and rest. In other words, as intrapersonal resources are consumed, they may not be available to individuals to call upon in the future. The individual becomes decreasingly capable of withstanding further threat, risking a downward performance spirals (Gorgievski & Hobfoll, 2008; Hobfoll, 1989).

In nurses' work, inpatient nursing care tends to occur in sequential patient care episodes, wherein nurses enact a number of care activities while providing care to one patient before moving on to the next. This work pattern aligns well with the episodic model of performance as

naturally segmented work performance episodes are thematically organized around the care of a patient. Figure 6 illustrates an example sequence of patient care episodes, wherein the length of horizontal line represents a nurse's work day; the brackets underneath the line represent care episodes; the letters above the line identify the tasks within each care episode; and the Xs refer to interruptions.

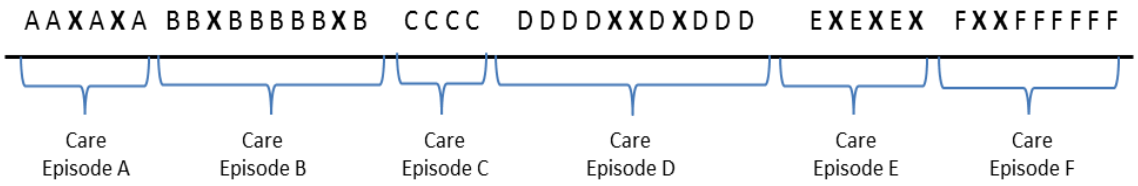


Figure 6. Nurse care episodes.

In this study I propose that: (a) nurses must use multiple psychological resources to contend with interruptions, (b) these resources tend to become depleted over time, and (c) as resources become depleted, interruptions pose the threat of causing downward performance spirals in nurses. Take the example of a nurse who is interrupted by a physician during care episode A. After communicating with the physician, the nurse continues caring for the patient in episode A. While completing tasks in episode A, the nurse appraises the information that the physician conveyed as trivial and finds the interruption to have been annoying. Employing self-regulation resources, the nurse maintains focus and accurately completes the tasks during episode A.

The nurse moves on to the next patient in care episode B. While completing tasks in episode B, the nurse ruminates on the interruption, and experiences heightened emotional arousal, becoming increasingly frustrated with the physician's disregard for her task priorities. Ruminating on the event distracts the nurse and contributes to her working memory load.

Contending with the frustration requires self-regulation resources, some of which the nurse already utilized in care episode A. In turn the nurse's attentional focus is diverted from checking Patient B's medication orders, and she accidentally administers the wrong dose of a medication.

In this example, the nurse experienced an interruption and consequential negative emotion within care episode A. In the subsequent episode the nurse experienced no additional interruptions, but remained distracted by ruminating on the prior episode's event. In turn, an MAE occurred during care episode B. Thus, the nurse experienced a downward performance spiral as a result of an interruption occurring in a prior care episode. Based on this simple example, one can conceive of more complex downward performance spirals with compounded effects from continued negative events in subsequent episodes. Hypothesis 7 therefore states:

H_7: The mediating effect of interruptions on task completion rate, MAEs, perceived stress, positive affect, and negative affect occurring during a patient episode will contribute to (a) task completion rate, (b) MAEs, (c) perceived stress, (d) positive affect, and (e) negative affect in subsequent care episodes.

Section III: Human Characteristics

Buffering Role of Intrapersonal Resources

This final section focuses on the characteristics that nurses possess within themselves and can buffer the detrimental effects of interruptions. According to JD-R, one's intrapersonal job resources may play a protective role in employee performance and well-being by reducing job demands and their associated physiological and psychological costs (Bakker & Demerouti, 2007). The episodic model of performance asserts that successful performance at any point in the workday is dependent upon the psychological resources individuals have available to them and their ability to deploy the necessary resources at the appropriate time (Beal et al., 2005).

However, these resources are not distributed evenly among individuals (Hobfoll, 1989). Individuals may possess certain intrapersonal resources in higher levels than others. Additionally, individuals who lack resources are more vulnerable to the losses caused by excessive job demands (Hobfoll, 1989).

Thus, the intrapersonal resources available to an individual are of utmost importance. As previously described, different job demands require different resources. In terms of the demands of interruptions, individuals with insufficient intrapersonal resources may find it difficult to manage heightened emotional reactions, process information mindfully, and take appropriate action when performing interrupted tasks (Jett & George, 2003). In order for nurses to properly manage care tasks, they must plan for, manage, and overcome interruptions and their accompanying off-task attentional demands (Steel, 2007). Thus, certain intrapersonal resources will be more useful in buffering, or protecting, against the job demands of interruptions, especially at certain phases of the interruption process. The remainder of this chapter seeks to posit the specific intrapersonal resources that may buffer against the negative effects of interruptions.

Intrapersonal resources have thus far been described as an array of psychological resources that individuals have available to them. These resources are often distinguished as emotional states and personality traits. States tend to be conceptualized as momentary emotions or moods triggered by internal or external events (Spielberger, 2006). Traits, on the other hand tend to be conceptualized as more stable, consistent, and enduring dispositions (Allport & Odbert, 1936). Whereas states respond to situational, variable, or temporal factors, traits present the tendency for an individual to think and behave in a certain way (Hamaker, Nesselroade, & Molenaar, 2007).

A range of these state- and trait-characteristics has been described in the literature. I therefore posit three specific intrapersonal resources that can be deployed throughout the interruption process to buffer against their deleterious effects: stress mindset, conscientiousness, and psychological resilience. The three intrapersonal resources are posited to buffer the effects of interruptions by allowing nurses to be prepared for (i.e., positive stress mindset), manage (i.e., conscientiousness), and overcome (i.e., psychological resilience) interruptions and their accompanying off-task attentional demands (Steel, 2007).

Stress mindset. Stress mindset is a newly emerging state characteristic in the literature, and may influence how nurses perceive stress (Crum, Salovey, & Achor, 2013). Recent research suggests that the way individuals approach stress both psychologically and behaviorally depends upon one's stress mindset, or the attributes and expectations one ascribes to stress (Crum et al., 2013). Thus, stress mindset represents one's beliefs about the nature of stress in general and remains in play whether one is currently experiencing a stressor or not. Individuals tend to approach stress in one of two ways: with a negative or positive stress mindset (Crum et al., 2013).

Individuals with a negative stress mindset tend to perceive stress as debilitating (Crum et al., 2013). They tend to perceive stress as bad, and something that should be generally avoided (Crum et al., 2013). On the other hand, individuals with a positive stress mindset tend to perceive stress as enhancing, accepting stress as a positive force with the potential to energize and possibly enhance performance outcomes (Crum et al., 2013). Nurses who approach their work with a positive stress mindset may be less negatively affected by the stress that interruptions create. A positive stress mindset should allow nurses to approach the stress of interruptions with a positive outlook, thus mitigating their negative effects.

H_8: The mediated relationship between room-type and (a) task completion rate, (b) MAEs, (c) perceived stress, (d) positive affect, and (e) negative affect is weaker for those nurses who view stress as enhancing compared to those who view stress as debilitating.

Conscientiousness. Conscientiousness is considered a personality trait characteristic. It is one of the "Big Five" personality traits which have received much attention in psychological literature (Digman & Takemoto-Chock, 1981; Digman & Inouye, 1986; McCrae & Costa, 1985; Norman, 1963; Tupes & Christal, 1992). The Big Five domains of personality trait (conscientiousness, agreeableness, neuroticism, openness to experience, and extroversion) each have clustered within them more specific or correlated components.

Conscientiousness may have multiple protective factors that could buffer against the effects of interruptions. Conscientiousness encompasses such traits as being highly organized, thorough, and reliable (Steel, 2007). Conscientiousness also aids in one's ability to block out distractions, a quality seen as crucial for goal attainment (i.e., task completion) (Locke & Latham, 1990). Research has shown that conscientiousness is negatively associated with cognitive failure (Matthews, Coyle, & Craig, 1990). Individuals who are less vulnerable to cognitive failures (i.e., higher in conscientiousness) tend to cope more actively with problems caused by interruptions than individuals that are more vulnerable to such failures (Elfering et al., 2011; Matthews et al., 1990). Conscientiousness therefore influences to what extent nurses can maintain focus in the face of interruptions (Steel, 2007). Therefore :

H_9: The mediated relationship between room-type and (a) task completion rate, (b) MAEs, (c) perceived stress, (d) positive affect, and (e) negative affect is weaker for those high in conscientiousness compared to those low in conscientiousness.

Psychological resilience. If interruptions present as stressors in the work place, then individuals must evoke coping mechanisms in order to contend with them. Positive affect and its closely related construct positive emotion, is seen as playing a role in coping with or bouncing back from stressors (Folkman, 1997). In terms of emotional states and traits, affect is considered more long-lasting than discrete emotions themselves, but the two are strongly related (Fredrickson, 2001).

Positive emotion or affect alone does not assist individuals in coping. Rather, positive affect and emotion are "ingredients" in coping mechanisms that allow individuals to contend with adversity (Fredrickson, Tugade, Waugh, & Larkin, 2003, p. 366). They play a role in how individuals appraise events (Folkman & Lazarus, 1985) and stressors (Folkman & Moskowitz, 2000), as well as in how individuals cope with them (Fredrickson et al., 2003). Specifically, positive emotions broaden people's attention, thinking, and behavioral repertoires (Fredrickson, 2001). In turn, the broadening triggered by positive emotions expands and improves the ways people cope with adverse events (Frederickson, 2001; Fredrickson et al., 2003).

One particular coping trait that the recurrent experience of positive emotions may help people build is psychological resilience (Fredrickson 2001). Psychological resilience is an intrapersonal resource that is specific to coping and adaptation in the face of loss, hardship, or adversity (Fredrickson et al., 2003; Tugade & Fredrickson, 2004). It is viewed as a relatively stable personality trait that equips individuals with the ability to "bounce back" from negative experiences (Tugade & Fredrickson, 2004). Thus, psychological resilience may equip nurses to quickly recover from the effects of interruptions (Fredrickson et al., 2003; Tugade & Fredrickson, 2004). Therefore, I offer the final hypothesis:

H_{10}: The mediated relationship between room-type and (a) task completion rate, (b) MAEs, (c) perceived stress, (d) positive affect, and (e) negative affect is weaker for those high in psychological resilience compared to those low in resilience.

Summary

In sum, I test the following hypotheses to address my research questions:

Research Question 1: Does frequency of interruptions differ by patient room type?

H_1: Nurses providing care in DO rooms will experience more interruptions than when providing care in SO rooms.

Research Question 2: Does room-type mediate the relationship between interruptions and (H_2) task completion, (H_3) MAEs, (H_4) perceived stress, and experience of (H_5) positive affect, and H_6) negative affect?

H_2: Interruptions mediate the effect of room-type on task completion rate, where increased frequency of interruptions decreases task completion rate.

H_3: Interruptions mediate the effect of room-type on MAEs, where increased frequency of interruptions increases rate of MAEs.

H_4: Interruptions mediate the effect of room-type on perceived stress, where increased frequency of interruptions increases perceived stress.

H_5: Interruptions mediate the effect of room-type on positive affect, where increased frequency of interruptions decreases experience of positive affect.

H_6: Interruptions mediate the effect of room-type on negative affect, where increased frequency of interruptions increases experience of negative affect.

Research Question 3: Do interruptions occurring early in a nurse's shift continue to have negative consequences later in the shift?

H_7: The mediating effect of interruptions on task completion rate, MAEs, perceived stress, positive affect, and negative affect occurring during a patient episode will contribute to (a) task completion rate, (b) MAEs, (c) perceived stress, (d) positive affect, and (e) negative affect in subsequent care episodes.

Research Question 4: Do certain intrapersonal resources of nurses (operationalized as stress mindset, conscientiousness, and psychological resilience) mitigate the negative effects of interruptions?

H_8: The mediated relationship between room-type and (a) task completion rate, (b) MAEs, (c) perceived stress, (d) positive affect, and (e) negative affect is weaker for those nurses who view stress as enhancing compared to those who view stress as debilitating.

H_9: The mediated relationship between room-type and (a) task completion rate, (b) MAEs, (c) perceived stress, and (d) positive affect, and (e) negative affect is weaker for those high in conscientiousness compared to those low in conscientiousness.

H_{10}: The mediated relationship between room-type and (a) task completion rate, (b) MAEs, (c) perceived stress, and (d) positive affect, and (e) negative affect is weaker for those high in resilience compared to those low in psychological resilience.

Chapter 4 describes the study's methodology including the study design, sample, data sources, variables and accompanying measurements, and the analytical techniques used in the study. Chapter 5 presents the results of the study. Finally, Chapter 6 closes with a discussion of the results, recommendations for future research, and the study's limitations.

Chapter Four: Methodology

This chapter explains the research and statistical methods used to explore the nature of the relationships between patient room-type, interruptions, and nurse performance and well-being, as well as the potential for nurse intrapersonal resources to act as buffers against the effects of interruptions. The first section describes the research design. The next four sections describe the preliminary work done as ethnographic reconnaissance prior to the study; the study setting and participants; variable measurement, and the statistical analysis employed to investigate the research questions. The final section describes steps taken to ensure the protection of risks presented to human participants in the study.

Research Design

This study adds to the growing body of observational studies intended to explain and predict the effects of interruptions in the health care setting. I approached this study from a realist perspective in that I sought to study a phenomenon (process of nursing task accomplishment and emotional experiences) in such a way that the findings would correspond as much as possible to what happens in the real world of nursing (Patton, 1990). To accomplish this, I employed a nonexperimental research design to examine differences in response to interruptions within and across nurses working on a single hospital unit at a large academic health center. Additionally, this study determined if patient room-type operates as a predictive antecedent of interruptions in the hospital setting. Measures come from a combination of one-

time questionnaire, daily survey, episodic survey, direct observation of nurses, and medical record review.

Preliminary Observations

In March of 2013, the researcher observed and interviewed the nurses of the proposed hospital unit as part of a class project for a qualitative research course. These observations and interviews served as an opportunity to conduct ethnographic reconnaissance (Wolcott, 1999), a qualitative field technique with four goals of (a) building rapport, (b) getting to know the hospital unit and its nurses, (c) determining the feasibility of the proposed study, and (d) developing observation protocols for this study. At that time, the nurses and unit manager expressed an eagerness for the differences in room types to be studied. They described challenges to providing patient care in the DO room type, and expressed that they often complete reports related to patient safety issues arising in DO rooms. Based on the ethnographic reconnaissance, it appears that DO rooms are a more interruptive work environment than SO rooms, worthy of studying through an in-depth quantitative analysis, feasible through direct observation. Additionally, both the health system's Director of Medical and Geriatric Nursing and the Nurse Research Council expressed an interest in the potential research findings and both encouraged the researcher to proceed with the project.

Study Setting and Participants

To test the developed hypotheses, this study took place in a single progressive care hospital unit of the Virginia Commonwealth University (VCU) Health System, selected for having both SO and DO inpatient rooms (i.e., nurses on this unit provide care to patients in both room types during any given shift). The majority of hospitals in the United States differentiate and board patients according to acuity level. Patient acuity is a broad term used in the health

sciences literature. It encompasses patient attributes of illness severity and intensity, and is often categorized according to the level of physical, psychological, and nursing care which the patient requires (Brennan & Daly, 2009). Patients are typically categorized as needing critical care (the highest level of acuity), step-down or progressive care (an intermediate level of acuity), and general acute care (the lowest level of acuity). Progressive care units typically board patients who need their heart rhythm and respiratory patterns continuously monitored, but do not require the extent of care provided in critical care unit. This is the case for the progressive care unit to be observed.

Data Sources

Data came from the following sources:

1. Nurse-level intrapersonal resource and demographic data obtained via one-time structured questionnaire administered prior to the onset of observations;
2. Preshift measures obtained via a one-time daily survey administered to each nurse at the onset of his or her shift;
3. Episodic measures obtained via episodic surveys administered to each nurse prior to his or her entrance and exit of each patient room;
4. Episodic measures obtained by the researcher via direct observation; and
5. Episodic measures obtained by the researcher via a review of medication orders.

See Figure 7 for a data collection flow chart that outlines the timing of each data collection method. The above enumerated data sources are next explained in detail.

One-time structured questionnaires (1). After obtaining informed consent, nurse participants completed a structured questionnaire to obtain nurse-level demographic data and assess the intrapersonal resources that are hypothesized to mitigate the deleterious effects of

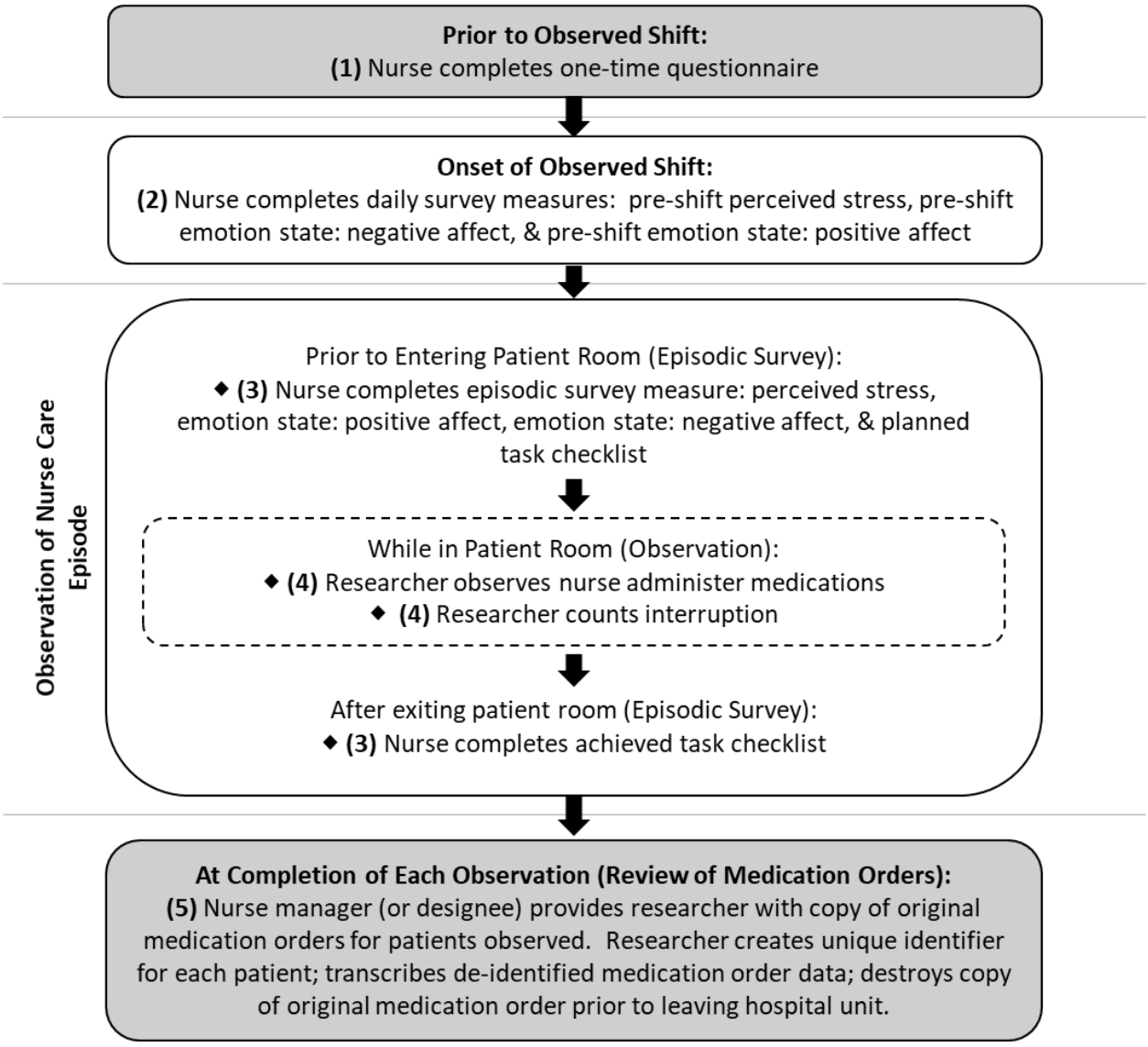


Figure 7. Data collection flowchart.

interruptions (stress mindset, resilience, and conscientiousness). The observer was blind to the questionnaire data in order to ensure that observations were not biased by knowledge of a nurse's intrapersonal resources. See Appendix B for a copy of the one-time structure Nurse Questionnaire.

Daily surveys (2). Preshift measures (preshift perceived stress, preshift positive affect, and preshift negative affect) were obtained via a one-time daily survey administered to each

nurse at the onset of his or her shift. Nurses were then oriented to the episodic measures that were collected at the start and end of each care episode. See Appendix C for a copy of the daily preshift survey.

Episodic surveys (3). Prior to entering and upon exiting the patient room, episodic measures were obtained via episodic survey. Prior to entering the patient room, each nurse completed the episodic survey to indicate the extent to which he or she was experiencing perceived stress and the emotion states of positive and negative affect. In addition, each nurse was asked to complete a planned task checklist. Upon exiting the patient room, the nurse then utilized the episodic survey to complete the achieved task checklist. See Appendix D for a copy of the episodic survey and tasks checklist.

Nurse care episodes. This process of completing the episodic survey was completed for each nurse care episode. Nurse care episodes are defined as naturally segmented patient care activities which are sequentially organized around patient encounters. Each care episode consists of all nursing care tasks completed during the encounter with the patient, such as physical assessment of patient, administration of medications, documenting nursing care in the patient record, etc.. These care episodes occur within the patient room. Figure 8 illustrates an example of care episodes, wherein the length of horizontal line represents a nurse's shift; the brackets underneath the line represent care episodes; the letters above the line identify the tasks within each care episode; and the Xs refer to interruptions.

Direct observations (4). Nurse care episodes were observed by the researcher as care was provided in both SO and DO rooms. The researcher counted interruptions as well as observed the nurses administer medications. Observation is considered appropriate for

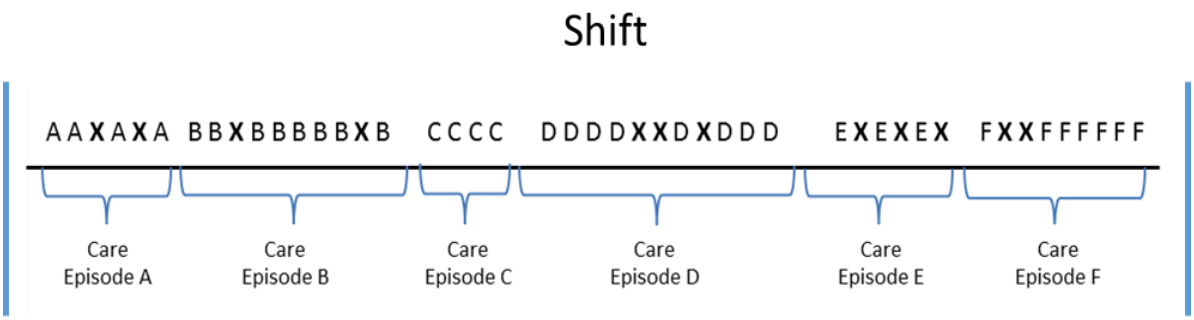


Figure 8. Example of nurse care episodes.

identifying both interruptions and MAEs (Allan & Barker, 1990; Biron et al., 2009; Rivera-Rodriguez & Karsh, 2010). Observation of MAEs most accurately identifies the largest number and most comprehensive range of errors compared with chart/incident report review and self-reporting (Allan & Barker, 1990; Flynn, Barker, Pepper, Bates, & Mikeal, 2002; Keers, Williams, Cooke, Walsh, & Ashcroft, 2014). According to the unit manager, the nurses on the hospital unit of study tend to work 12- hour shifts that begin at either 7 a.m. or 7 p.m. Observations occurred on both day and night shifts, and began at the start of each nurse's shift.

Review of medication orders (5). After completion of all observations, the researcher checked the accuracy of administered medications against the original medication order, and verified any potential MAEs with the nurse. This step was crucial to the accuracy of MAE data and provided an immediate feedback loop to the nurse in the case that an MAE had occurred unbeknownst to the nurse.

Measures

For each variable, Appendix E displays the variable's type, construct or concept it measures, data source, a citation for the justification of its use, and an indication of whether or not the variable was used in the final models. Appendix E is organized according to the role the

variable plays in the conceptual model (control variables, moderators, independent variable, mediator, and dependent variables).

The table also includes the level at which the variable is included in the multilevel analyses. In multilevel analysis, relationships between variables are defined at different levels of a hierarchical data set, such as individuals (Level-1), within groups (Level-2), or repeated measures (Level-1) within individuals (Level-2) (Hox, Maas, & Brinkhuis, 2010). In this study, variables that occur within a care episode repeat for individual nurses. Thus, variables that occur within an episode of care are considered episode-level, or Level-1, variables. Variables that occur for the individual nurse are nurse-level, or Level-2, variables.

Multilevel modeling also allows researchers to understand whether relationships between lower-level variables change as a function of higher-order moderator variables. This type of relationship is estimated using a cross-level interaction effect. In this study, the Level-1 dependent variables (task completion, MAE rate, perceived stress, positive affect, and negative affect) are posited to change as a function of the cross-level moderators (stress mindset, psychological resilience, and conscientiousness).

Control variables. Nurse demographic data, collected via one-time structured questionnaire (Appendix B) prior to the nurse's observed shift, served as nurse-level (Level-2) control variables—nurse gender, age, education level, tenure on hospital unit as well as total experience as a nurse. These demographic data have been used in past research investigating MAEs and performance (DeBack & Mentkowski, 1986; Keers, Williams, Cooke, & Ashcroft, 2013a; McCloskey & McCain, 1988).

Preshift perceived stress and preshift affect were also planned to be entered as Level-2 control variables. These preshift measures were collected via the one-time daily survey (Appendix C) at the onset of the nurse's shift.

Preshift perceived stress. Because a nurse's stress at the beginning of a work shift can influence his or her perceived stress for the remainder of the day, I controlled for preshift emotional state. A modified version of the Perceived Stress Scale was used to measure preshift stress (see Appendix D) (Cohen, Kamarck, & Mermelstein, 1994). At the onset of the shift, the nurse used a 6-point Likert-type scale ranging from 0 (*Strongly Disagree*) to 5 (*Strongly Agree*) to identify the extent which they agree or disagree with each statement. These stress measures are adapted from the short-form PSS which is recommended by Cohen et al. (1994) when using the PSS for repeated measures. Preshift stress is measured as a continuous variable.

Preshift affect. Similarly, a nurse's emotional state at the beginning of a work shift can influence his or her emotional state for the remainder of the day (Gabriel et al., 2011). I thus controlled for preshift emotional state. At the onset of the shift, the nurse identified his or her emotion "*at* this moment" via a 6-point Likert-type scale ranging from 0 (*Strongly Disagree*) to 5 (*Strongly Agree*) which assesses to what extent the nurse is experiencing each of two types of emotions: negative (anger, frustration, anxiety, irritation, and sadness) and positive (calmness, excitement, happiness, and pride). Gabriel and colleagues (2011) found that reduced measures of positive and negative emotions are an appropriate proxy of Erickson and Ritter's original 15 positive and negative emotion adjective measure (Erickson & Ritter, 2001), with internal consistency reliabilities ranging from 0.80 to 0.87. Preshift affect is measured as a continuous variable.

Cross-level moderators. Variables representing individual nurse intrapersonal resources are measured at the nurse-level, and were entered into the model as cross-level moderators. These cross-level moderators were collected via one-time structured questionnaire prior to the nurse's observed shift (Appendix B). To avoid confusing the respondents, all nurse characteristic measures used a 6-point Likert-type scale ranging from 0 (*Strongly Disagree*) to 5 (*Strongly Agree*). Past research has suggested that relatively minor alterations to response formats do not affect their validity (Matell & Jacoby, 1971). For each measure, the nurses were asked to consider their feelings over the past few months.

Stress mindset. Stress mindset is examined with an 8-item Stress Mindset Measure (Crum, Salovey, & Achor, 2013). Following Crum et al. (2013), stress mindset scores were obtained by reverse scoring the four negative items and then taking the mean of all eight items. Higher scores represented the mindset that the effects of stress are enhancing. Previous research has found a coefficient alpha estimate of internal consistency for these items of 0.86 (Crum et al., 2013). Stress mindset is measured as a continuous variable.

Psychological resilience. Psychological resilience was examined with a 6-item scale based on Cole, Bruch and Vogel's (2006) Psychological Hardiness/Resilience Scale. Previous research has demonstrated the validity of combining all the 6 items into one overall resilience score (Connor & Davidson, 2003). Resilience is measured as a continuous variable.

Conscientiousness. Conscientiousness was examined using items on the 10-item conscientiousness scale developed by Goldberg's International Personality Item Pool scales measuring conscientiousness factor of the Big Five Domains (Goldberg, 1999). Conscientiousness scores were obtained by reverse scoring the four negative items and then taking the mean of all eight items. Previous research has found a coefficient alpha estimate of

internal consistency for these items of 0.79 (Goldberg, 1999). Conscientiousness was measured as a continuous variable.

Independent variable (room-type). Room-type describes whether the patient room is in either a SO or DO patient room. Room-type is measured as a binary variable and was directly observed by the researcher during each episode of care.

Mediator (interruptions). For the purpose of this study, interruptions are defined as any observable events (except those which were initiated in conversation by the patient) which direct the nurse's attentional focus away from the patient care task at hand (Beal et al., 2005). Examples of interruptions to nursing care that have been previously observed on this particular hospital unit (see Preliminary Observations) include nurses receiving calls or pages while providing care; nurses stopping care of their assigned patient to check an alarm or assist in a care task for another patient; other nurses and team members asking questions; and interactions with patients' roommates, patient's family, or roommate's family. The decision to exclude patient-initiated communications was made due to the fact that a patient's talkativeness could greatly skew the frequency of interruptions observed. Interruptions were directly observed and counted by the researcher during each episode of care. Interruptions were measured as interval variables.

Dependent variables. Dependent variables in this study are task completion, MAE, perceived stress, and episodic positive and negative affect. Each of these dependent variables are described below and were collected via episodic surveys conducted with each nurse (see Appendix D).

Task completion. At the onset of each care episode, the nurse was asked to identify the patient care tasks that he or she planned to complete during each care episode via the episode survey (Appendix D). These tasks were adapted from a list of common nurse tasks (Aiken et al.,

2000). Immediately following each care episode, the nurse then identified which tasks were completed (Appendix D). Task completion rate was calculated as a percentage of tasks completed out of total planned tasks. Task completion was measured as a continuous variable.

***Medication administration error rate*.** During each performance episode, medication administration was directly observed, and MAE rate was later calculated utilizing a combination of direct observation and review of medical records. In this study, an MAE is defined as a deviation from the prescriber's medication order as it appears in the computerized physician order entry (Keers, Williams, Cooke, Walsh, & Ashcroft, 2013b). Based on previous MAE research (Keers et al., 2013b), the denominator used for the MAE rate was the total opportunity for error, defined as the total number of doses scheduled plus any extra doses given. The rate of MAEs is then defined as: Number of medication doses having one or more types of MAEs/Total number of doses scheduled plus any extra doses given.

The numerator was further defined as the number of doses considered to have one or more types of MAEs, categorized as follows. According to the Allan and Barker (1990), MAEs can be categorized as omission error (assuming no prescribing error, the failure to administer an ordered dose to a patient before the next scheduled dose); wrong time error (administration of a medication outside the institution's predefined time interval from its scheduled administration time); wrong dose error (administration to the patient of a dose that is greater than or less than the amount ordered by the prescriber or the administration of duplicate doses to the patient in addition to those that were ordered); wrong dosage-form error (administration to the patient of a drug product in a different dosage-form than ordered by the prescriber—e.g., oral versus injection); unauthorized drug error (administration to the patient of medication not authorized by

a legitimate prescriber for the patient); and unordered-drug error (the administration of a medication to a patient other than the patient ordered to receive the dose).

At the end of the observation period, the observed administered doses were checked against the original medication order and verified with the observed nurse. Frequency of MAEs were recorded and MAE rate was measured as continuous variable

Episodic positive and negative affect. Immediately following each care episode, the nurse identified his or her emotion via a 6-point Likert-type scale ranging from 0 (*Strongly Disagree*) to 5 (*Strongly Agree*) which assesses to what extent the nurse is experiencing each of two types of emotions: negative (anger, frustration, anxiety, irritation, or sadness) and positive (calmness, excitement, happiness, or pride (Appendix D) (Gabriel et al., 2011). Episodic affect was measured as a continuous variable.

***Perceived stress*.** A modified version of the Perceived Stress Scale (PSS) (Cohen et al., 1994) was used to measure episodic stress (see Appendix D). Immediately following each care episode, the nurse used a 6-point Likert-type scale ranging from 0 (*Strongly Disagree*) to 5 (*Strongly Agree*) to identify the extent which the participants agreed or disagreed with each statement. These stress measures were adapted from the short-form PSS which is recommended by Cohen et al. (1994) when using the PSS for repeated measures. Perceived stress was measured as a continuous variable

Statistical Analysis

Data management of the observed and collected data performed using SPSS for Windows® (64-bit), Version 25.

Sample size. The hospital unit of study typically employs approximately 50 nurses. The goal was to maximize the sample size by recruiting as many nurses as possible to participate, and

a high response rate was anticipated. It is well recognized that in multilevel modeling moderate Level-2 sample sizes of 30 yield sufficient power (Hox et al., 2010; Maas & Hox, 2004; Raudenbush & Bryk, 2002). To that end, a goal of a minimum of 30-45 nurses was set; however, only 20 nurses were recruited to participate in the study, resulting in a total of 120 observations. Though 20 appears to be a relatively small sample size for Level-2 analyses, the 120 total observations result in a higher power for Level-1 analyses.

Preliminary analysis. Several preliminary analyses were performed to assess the quality of the data. Missing data were contended with in all regression models via listwise deletion which is necessary when using MPlus® software to converge multivariate multilevel models. Univariate examination of nurse demographics was conducted utilizing distributive properties and frequencies. Internal reliability of the nurse-level and episode-level scales was assessed. Between-individual (i.e., nurse-level) and within-individual (i.e., episode-level) relationships were examined via binary correlations. Finally, before conducting analysis associated with Research Questions 2-4, a series of null models was run to confirm that there is sufficient within-person variance for the event-level variables.

Hypothesis Testing and Empirical Specifications

Research Question 1. Research Question 1 asks if frequency of interruptions differ by patient room type. To answer this question, I tested:

H_1: Nurses providing care in DO rooms will experience more interruptions than when providing care in SO rooms.

To test H_1, I planned to use a *t*-test of significance to test for significant differences in interruption frequency by room type. Its specification follows:

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}}}$$

where subscripts 1 and 2 denote DO- and SO rooms respectively; $\bar{x}$ is mean interruptions; *S* is standard deviation; and *n* is the total number of interruptions.

Research Question 2. Research Question 2 asks if room-type mediates the relationship between interruptions and H_2 task completion, H_3 MAEs, H_4 perceived stress, and experience of H_5 positive affect, and H_6 negative affect. The empirical specification for H_2–H_6 is based on the notion that care episodes were nested within nurses, meaning the likelihood of interruptions affecting the dependent variables (task completion, MAEs, stress and negative emotion) is expected to differ across nurses. Episodic-level independent variables were modeled at the lowest level (Level-1) with subscript *i* and nurse-level characteristics at the higher level (Level-2) with subscript *j*. The model may be expressed by the following equation:

$$Y_{ij} = \beta_0 + \beta_1(RT)_{ij} + \beta_2(INT)_{ij} + \beta_3(CNTR1)_{ij} + \beta_4(CNTR2)_j + u_j + \epsilon_{ij}$$

where subscripts i = 1, 2, . . .6 episodes and j = 1, 2, …, n nurses, Y_{ij} represents each of the five dependent variables measured (i.e., task completion, MAEs, perceived stress, positive affect, and negative affect), and β_0 represents the average value of each dependent variable when all covariates equal zero. In the remainder of the model, $(RT)_{ij}$ is a binary variable representing room type (1 = SO room; 0 = DO rooms, $(INT)_{ij}$ is the frequency of interruptions, $(CNTR1)_{ij}$ is

vector of episode-level control variables, $(CNTR2)_j$ is a vector of nurse-level control variables, u_j is the error variance across episodes, and ϵ_{ij} is the error variance across nurses.

To test H_2–H_6, single-level mediation effects were tested utilizing a combination of random coefficient models of mediation (Muthen & Muthen, 2017) and statistical inference through bootstrap confidence intervals via the MCMAM (MacKinnon, Lockwood, & Williams, 2004). A variable is considered a mediator if it transmits an indirect effect of the independent variable through to a dependent variable. The MCMAM uses the parameter estimates of (*a*) the unstandardized regression coefficient for the association between the independent variable and the mediator and (*b*) the unstandardized regression coefficient for the association between the mediator and the dependent variable and their associated asymptotic variances and covariance. Random draws from the joint distribution of (*a*) and (*b*) are simulated and the product of these values is computed. This procedure is repeated 20,000 times and the resulting distribution of the product of the (*a*) and (*b*) is used to estimate a confidence interval around the observed values (*a*) and (*b*). The mediation effect is considered significant if the 95% Confidence Internal generated does not include zero. To do this, four separate multilevel regression analyses were planned with interruptions mediating the relationship between room type and the hypothesized dependent variables (H_2: task rate, H_3: MAEs, H_4: perceived stress, H_5: positive affect, and H_6: negative affect).

Each random coefficient model for H_2–H_6 was analyzed using MPlus for Windows® (64-bit), Version 8 to generate parameter estimates (γ), standard errors (SE), and *p*-values of the mediation effect and the bivariate relationships comprising it. Statistical inference via the

mediation was conducted utilizing Rweb 1.03 on the server at *rweb.stat.umn.edu* to generate confidence intervals (CI) for the mediation effects.

Research Question 3. Research Question 3 asks if interruptions occurring early in a nurse's shift continue to have negative consequences later in the shift. To test the downward performance spiral hypothesized in H_7, wherein dependent variables (task completion, MAEs, perceived stress, positive affect, and negative affect) from one care episode were predicted to impact on subsequent care episodes, I planned to repeat each of these random coefficient mediation models, regressing the dependent variables of each care episode on the lagged dependent variables from the previous care episode.

The empirical model is based on the hypothesis that a single care episode's outcomes affect subsequent care episodes. The model may be expressed by the following equations:

$$YT_i = \beta_0 + \beta_1 (DVT - 1)_i + \epsilon_i$$

where subscripts i = 1, 2, . . .6 episodes and j = 1, 2, …, n nurses, Y_{ij} represents each of the five dependent variables measured (i.e., task completion, MAEs, perceived stress, positive affect, and negative affect) in a given episode; β_0 represents the average value of each dependent variable when all covariates equal zero; $(DVT - 1)_i$ represents a vector of lagged values of the dependent variables from the preceding episode; and ϵ_i is the error variance across episodes.

Research Question 4. Research Question 4 asks if certain intrapersonal resources of nurses (H_8–H_{10}) mitigate the negative effects of interruptions. To test H_8–H_{10} which incorporates cross-level moderators (stress mindset, conscientiousness, and psychological

resilience) into the mediation model, a simultaneous multilevel path analysis was planned. The simultaneous analysis allows for testing the mediation pathway on the five posited dependent variables, while also simultaneously testing the effect of the three posited cross-level moderators. MPlus for Windows ® (64-bit), Version 8 is used to generate intercepts, parameter estimates (γ), standard errors (SE), and *p*-values of the bivariate relationships comprising the simultaneous multi-level moderated mediation model.

The empirical model is also based on the notion that care episodes are nested within nurses, meaning the likelihood of interruptions affecting the five dependent variables (task completion, MAEs, perceived stress, positive affect, and negative affect) is expected to differ across nurses. It also incorporates the notion that nurse-level intrapersonal resources act as cross-level moderators that effect the dependent variables as a function of their interaction with interruptions. Episodic-level independent variables were modeled at the lowest level with subscript *i* and nurse-level independent characteristics at the higher level with subscript *j*. The model may be expressed by the following equation:

$$
\begin{aligned}
&Y_{ij} \\
&= \gamma_0 + \gamma_1(RT)_{ij} + \gamma_2(INT)_{ij} + \gamma_3(CNTR1)_{ij} + \gamma_4(SM)_j + \gamma_5(RES)_j + \gamma_6(CON)_j \\
&+ \gamma_7[(SM)_j \times \gamma_2(INT)_{ij}] + \gamma_8[(RES)_j \times \beta_2(INT)_{ij}] + \gamma_9[(CON)_j \times \gamma_2(INT)_{ij}] + \gamma_{10}(CNTR2)_j \\
&+ u_j + \epsilon_{ij}
\end{aligned}
$$

where subscripts *i* = 1, 2, . . .6 episodes and *j* = 1, 2, …, *n* nurses, Y_{ij} represents each of the four dependent variables measured (i.e., task completion, MAEs, negative emotion, and perceived

stress), and β_0 represents the average value of each dependent variable when all covariates equal zero. In the remainder of the model, $(RT)_{ij}$ is a binary variable representing room type (1 = SO room; 0 = DO rooms; $(INT)_{ij}$ is the frequency of interruptions; $(CNTR1)_{ij}$ is vector of episode-level control variables; $(SM)_j$ is [make this a vector instead] the intrapersonal resource of stress mindset; $(RES)_j$ is the intrapersonal resource of psychological resilience, $(CON)_j$ is the intrapersonal resource of conscientiousness; $(CNTR2)_j$ is a vector of nurse-level control variables, $u_j$is the error variance across episodes; and ϵ_{ij} is the error variance across nurses. $\gamma_7, \gamma_8,$ and γ_9 represent the interaction effect of their respective intrapersonal resources with interruptions.

Moderators exist when the relationship between two variables (*X* on *Y*) varies depending on the value of a third variable (*Z*). To evaluate the hypothesized moderation effect, a simple slopes test is conducted for any moderators with significant cross-level interaction effects on the relationship between interruptions and dependent variable (as identified in the MPlus® output of bivariate relationships comprising the simultaneous multilevel moderated mediation model). Because the interaction term alone does not explain the full nature of moderation effect, simple slopes tests offers an additional probe of the moderation effect (Robinson, Tomek, & Shumaker, 2013). The simple slopes test probes the effect of *X* on *Y* at high and low levels of *Z* using a simple regression line. The regression slopes are customarily derived at high values of *Z* (one standard deviation above the mean of *Z*) and low values of *Z* (one standard deviation below the

mean of *Z*). The empirical specification for testing the simple slopes of each moderator uses the following regression equation:

$$Y = \beta_1 X + \beta_2 Z + \beta_3 XZ + \beta_0$$

where *Y* is one of each of the five hypothesized dependent variables; *X* is the mediating effect of interruptions; *Z* is one of each of the three hypothesized moderators; *XZ* is the interaction term calculated as *X* multiplied by *Z*; β_0 is the intercept; β_1 is the effect of X on Y; β_2 is the effect of *Z* on *Y*; and β_3 is the effect of *XZ* on *Y*. This formula is algebraically regrouped and separated for high and low levels of each moderator, resulting in two regression models, one for each level of each moderator.

The interaction is then further probed by performing a t-test of the ratio of the coefficient to its standard error for each of the simple slopes (i.e., at high and low levels of *Z*) with the estimates of the covariances between the two coefficients representing the estimated association between the coefficient values across the sampling distribution. The *t*-test of the ratio of the coefficient to its standard error for each of the simple slopes is expressed in the following equation:

$$t = \frac{\beta_1 - \beta_2}{\sqrt{\frac{n_1 SE_1^2 + n_2 SE_1^2}{n_1 + n_2 - 2}}}$$

For a final probe, the simple slopes of the mediation effects are tested for significance via the MCMAM, again at high and low levels of the moderator. The moderator is considered significant if either of the MCMAM tests are significant.

Protection of Research Participants

This study (HM20008110) was approved on November 9, 2016 by expedited review according to 45 CFR 46.110 expedited categories 5 and 7 by the Virginia Commonwealth University Institutional Review Board's Panel A. The study involves both nurse and patient participants.

Recruitment and Informed Consent (Nurses)

Nurse participants were recruited directly from the hospital unit of study. The researcher obtained a list of potential nurse participants (registered nurses working on the unit at the time of study) directly from the nurse manager. Nurses were told that the purpose of the study was to examine the relationships between the physical hospital environment and nurse work processes. The opportunity to participate in the study was shared through direct contact, e-mails, and flyers. Direct contact occurred in one of two ways: face-to-face with the nurses during regularly scheduled staff meeting or via an information table (set up on the unit during typical lunch/dinner break hours). The researcher attended one staff meeting on day shift and once on night shift. In the following week, the researcher set up a recruitment table once during day shift and once on night shift.

Immediately following and during the researcher's attendance of the staff meetings and information table, flyers were placed on the unit in each nurse's mailbox. Also, e-mail invitations and introduction to the study were forwarded to each nurse working on the unit by the unit nurse manager. The e-mail invitation included: (a) the details of the study and the expectations of the study participants, (b) a statement detailing their rights as research participants, and (c) a request to complete the online consent form and online questionnaire. Those nurses who did not initially respond to the flyers or direct contact/individual e-mail

invitation received a follow-up hand-written letter detailing the same information as the e-mail. Nurses who responded to the written letter then received the e-mail invitation.

From the e-mail invitation and introduction, nurses were directed to a link to an online consent form. After obtaining informed consent, nurses were directed via hyperlink to complete a structured questionnaire to obtain nurse-level demographic data and assess the intrapersonal resources hypothesized to mitigate the deleterious effects of interruptions (stress mindset, resilience, and conscientiousness). The observer was blind to the questionnaire data in order to ensure that the observations are not biased by knowledge of a nurse's intrapersonal resources. At the end of the electronic questionnaire, nurses were directed to a hyperlink to a Google Form designed to allow nurses to sign up for an observation period. At the beginning of observations, the researcher then provided nurse participants an opportunity to review and discuss the informed consent document and study protocol to ensure ongoing consent.

Recruitment and Informed Consent (Patients)

Patient recruitment occurred at the time the nurse entered the patient's room. To decrease the amount of identifiable patient information, written consent for participating patients was waived by VCU's Institutional Review Board. Verbal consent was obtained instead of the researcher obtaining written consent. Nurse participants introduced the researcher immediately upon entering the patient room as a nurse and student of VCU. The nurse participant then asked permission for the researcher to observe the nurse while providing patient care. When patients expressed that they did not wish to be observed, the researcher exited the patient room and rejoined the nurse to continue the nurse's observation once the nurse completed care for said patient. For the remainder of that nurse's observations, the observer did not enter the said patient's room and did not observe the nurse while providing care for the patient.

Risks. There were no foreseeable physical risks to patients or nurses beyond what might be encountered in typical nursing activity and patient care. The observation protocol was designed to minimize intrusiveness to the nurse and patient care. Observations therefore should not have interfered with or delay patient care. Given that the nurses are frequently shadowed by nursing and other health professional students while providing care, the observations of this study should not have placed the patient at any additional risk. Similarly, the study observations should have felt no more intrusive to nurse participants than when being observed routinely by students or other care providers. The two primary risks to this study: (a) negative experience of nurse participants regarding use of deception, and (b) breach of confidentiality of data collected regarding nurse and patient participants.

Deception. Nurse participants were not told that the study specifically analyzed medication errors, interruptions, task completion, or their differences in SO versus DO patient rooms. This scientific rationale for this deception follows. In previous contact with the nurses, the nurse manager, and the former Director of Medical and Geriatric Nursing for Virginia Commonwealth University Health System, it was repeatedly pointed out that the nurses had a strong dislike for providing patient care in multiple-occupancy patient rooms. Because of this dislike, nurses may have knowingly or unknowingly sought to validate the hypothesis that DO rooms indirectly lead to more stress/negative emotion or disrupt their nurse performance, thus threatening the internal validity of the study. Additionally, the nurse's knowledge of being observed for task completion and medication error may increase risk of Hawthorne effect, also increasing threat to internal validity. Instead, all verbal and written communication regarding the study is referred to the purpose of the study as "to better understand the relationship between the physical hospital environment and nurse work processes."

Data and Storage Confidentiality

Raw nurse questionnaire data were collected and managed using Research Electronic Data Capture (REDCap®) electronic data capture tools hosted at VCU. REDCap® is a secure, web-based application designed to support data capture for research studies. Raw episodic survey data were collected from nurses via paper during nurse observations. Medication administration data and interruptions frequency were collected via paper during nurse observations. All questionnaire, episodic survey, and observation data were transcribed onto an Excel® spreadsheet prior to data analysis. Observation data collected on paper were stored in a locked cabinet in the researcher's office. Transcribed data were stored and managed in VCU Google Apps for Education Drives. The VCU contract with Google allows for secure cloud storage, storage of most data types, and control of permissions for all files in Google Drive. Data were only accessed by the researcher and dissertation committee. The transcribed electronic data were backed up on an encrypted USB drive stored in a locked cabinet in the researcher's office.

Privacy. Only the minimum amount of sensitive information needed for identification, recruitment, and the conduct of the study was utilized. Nurses on the unit were able to see when a participating nurse was being observed. Additionally, participating nurses were able to see other participating nurses' names when signing up for observation times. This was mentioned in the consent form. Otherwise, only the researcher and dissertation committee chair had access to identifiable nurse-level or patient-level data collected with protections already identified in the Data Security and Storage section of this chapter. Nurses may perform sensitive or private tasks, and/or ask patients about sensitive information during observations. The researcher, who is a licensed registered nurse, maintained patient privacy and dignity by following the American Nurses Association Code of Ethics. Additionally, if at any time patient asked the researcher for

privacy, or the nurse or researcher perceived that the patient was uncomfortable with the researcher's presence, the researcher stepped out of the patient room. Observation data in these instances were dropped from analysis. This occurred once during the entire study.

Patient protected health information. Information about medications administered to patients constitutes protected health information necessitating increased measures to ensure confidentiality. To ensure this confidentiality, no patient names left the hospital unit. Instead a code-key was created at the onset of each observation period which included, the patient name and a 4-digit identifier generated by the researcher. The code-key was utilized throughout each observation period but destroyed prior to exiting the hospital unit at the end of each observation period. Additionally, a cross-walk was created that included the 4-digit identifier, patient room number, and date. The cross-walk was stored on a secure encrypted file separately from all observation and medication order data sets. On observation documentation, patient data were identified by the 4-digit identifier and date/time of care. Medication orders for those patients observed were reviewed and transcribed into an electronic dataset at the end of each observation period, prior to exiting the hospital unit according to each patients' unique identifier. These orders were retrieved from the hospital's computer physician order entry system and provided to the researcher by the nurse manager (or designee). All copies of the original medication orders were destroyed prior to exiting the hospital unit.

Potential Benefits and Importance of Knowledge to Be Gained

Once the results of the study were analyzed, nurse participants were made aware of the aggregate outcomes of the study. This was done through a handout that was created to share the findings of the study, a report that was be created for the nurse manager and Nurse Research

Advisory Council. It was again emphasized that no individual nurse's data was released or made known.

Cost and Compensation

There were no costs to the patient or nurse participants. In terms of compensation, participating nurses were entered for a chance to win one of four $45 Amazon gift cards. Gift card winners were identified and distributed via unique gift certificate redemption numbers. To determine winners of the gift cards, at the end of the study, all nurse participants' unique 4-digit identifiers were written on equal sized/colored pieces of paper and placed into a hat. Four pieces of paper were drawn from the hat. Four printed Amazon gift cards with electronic redemption numbers were physically distributed to the nurse participant winners by the nurse manager.

Summary

This chapter identified the research design, data sources, study sample, variable measurement, statistical analyses, and steps taken to ensure the protection of study participants. This study employs an observational research design. Data elements from four different data sources were utilized: direct observation, questionnaire, episodic survey, and review of medical record. The study's four research questions were investigated through a variety of statistical methods culminating in a moderated mediation multilevel model. Empirical findings of these analytical models are presented in Chapter 5.

Chapter Five: Results

This chapter presents results of the statistical analyses. The first section reports descriptive statistics for explanatory, control, and outcome variables used in the study. The second section presents the results of hypotheses testing and accompanying statistical analysis, organized by research question. The final section is the summary of findings.

Observation Data

Of a possible 50 nurses who met the inclusion criteria for on the progressive care unit in which this study was conducted, 20 nurses were observed. Each nurse observation included six patient care episodes for a total of 120 nurse observations. Average patient care episode length was 9.73 minutes, ranging from less than 1 minute to 44 minutes (standard deviation of 8.17). Total observation time averaged approximately 4 hours per nurse, resulting in over 80 hours of nurse observations.

Nurse Demographics

Table 2 presents the descriptive analysis for nurse-level demographics: highest nursing related education level, nurse tenure on unit, total tenure as nurse, age, race, ethnicity, and gender. These demographic data were collected via a one-time structured questionnaire prior to the observed nurses' shifts. Missing data were determined by visual inspection, frequencies, and missing values analysis (Tabachnick & Fidell, 2007). There were no missing demographic data.

Nurse demographics were obtained for the 20 participating nurses via a one-time questionnaire. The majority of nurses were bachelor prepared (90%). A large majority of nurses

Table 2

Frequencies for Nurse Demographics (N = 20)

	n	%
Highest nurse education level:		
Associate degree	1	5.0
Bachelor's degree	18	90.0
Master's degree	1	5.0
Gender:		
Female	17	85.0
Male	3	15.0
Other	0	0
Race:		
White/Caucasian	16	90.0
Black/African American	2	10.0
American Indian/Alaskan Native	0	0
Biracial/Multiracial	2	10.0
Ethnicity:		
Hispanic/Latino	2	10.0
Not Hispanic/Latino	18	90.0
Tenure on unit:		
<6 months	1	5.0
6 months to 1 year	2	10.0
1 to 2 years	6	30.0
2 to 5 years	5	25.0
>5 years	6	30.0
Total nurse tenure:		
<6 months	1	5.0
6 months to 1 year	1	5.0
1 to 2 years	5	25.0
2 to 5 years	8	40.0
>5 years	5	25.0

were white (90%) non-Hispanic (90%) females (85%). The nurses had a range of experience working on the progressive care unit with most having greater than one year of experience: 1 to 2 years (30%); 2 to 5 years (25%); or greater than 5 years of experience on the unit (30%). In terms of total years of experience as a nurse, most had 2-5 years (40%). Average nurse age was 29 years, ranging from 22 to 41 (standard deviation of 5.59).

Nurse Psychological Resources

Table 3 provides descriptive analysis of nurse psychological resources collected via a one-time structured questionnaire administered prior to the observation of nurses' shifts: conscientiousness, stress mindset, and psychological resilience. These psychological resources act as nurse-level (i.e., Level 2) moderators in the multilevel statistical model. On average, nurses reported a stress mindset level of 3.59 (*SD* = 0.84) on a 1 to 5 point Likert-type scale, indicating a perception of stress moderately skewing towards viewing it as enhancing performance. On average nurses reported slightly higher than moderate levels of psychological resilience (on the rating scale of *1=Strongly Disagree* to *6=Strongly Agree*; *M* = 5.19, *SD* = 0.46) and conscientiousness (*M* = 5.20, *SD* = 0.527).

Table 3

Frequencies for Nurse Psychological Resources (N = 20)

	Min	Max	Mean	*SD*
Conscientiousness	4.00	5.90	5.20	0.52
Stress mindset	1.00	4.88	3.59	.84
Psychological resilience	4.33	5.83	5.19	.46

Internal consistency of nurse psychological resources. Correlations were used to determine internal consistency of measures of nurse psychological resources. Correlations at or

above 0.60 have been noted to be acceptable in previous literature (van Griethuijsen et al., 2015; DeVellis, 1991). Table 4 provides a summary of correlations of nurse-level scales.

Table 4

Summary of Nurse-Level Scale Reliability (N = 20)

	No. items	*n*	α	*SD* α
Conscientiousness	10	20	0.868	0.879
Stress mindset	8	20	0.875	0.879
Psychological resilience	6	20	0.721	0.765

Conscientiousness and stress mindset had a reliable level of internal consistency with correlations of 0.868 and 0.875, respectively. Psychological resilience had an acceptable level of internal consistency, as determined by a correlation of 0.721. Appendix F provides nurse-level scale correlations. In sum, measures of nurse psychological resources proved consistent with acceptable correlations.

Episode-Level Results

Episode-level results were collected from the nurses via episodic surveys conducted prior to and upon exiting their patients' rooms, direct observation, and review of mediation orders. At the episode level were three types of variables: independent (room-type), mediator (interruptions), and dependent variables (task completion, MAE, perceived stress, positive affect, and negative affect). Within the episodic data, four missing data points were found. Listwise deletion was used in response to missing data in all statistical analysis. In other words, if a data point was missing, the entire record was excluded from the mediation and moderated mediation analyses. This is a setting in the MPlus® software that is necessary in order to converge multivariate multilevel models.

Room-type. Of the 120 episodes of patient care observed, 69 episodes occurred in a DO room-type, with the remaining 51 episodes occurring in the SO room-type.

Interruptions. A total of 292 interruptions were observed. On average, 2.43 interruptions were observed per episode of patient care, ranging from 0 to 21 (standard deviation of 3.26). Table 5 presents a cross-tabulation of interruptions by patient room-type, indicating that interruptions occurred more frequently in DO room-types when compared to SO room-types.

Table 5

Interruptions by Room-Type

	Room-type	
	Single	Double
Number of interruptions	89	203

Dependent variables. The dependent variables in this study were task completion, MAE rate, perceived stress, positive affect, negative affect. Table 6 presents descriptive statistics for each dependent variable.

Table 6

Descriptive Statistics for Dependent Variables

	N	Average rate (%)	SD
Task completion rate	120	119	0.73

	N	Min	Max	Mean	SD
Perceived stress	120	1.00	5.33	2.11	0.90
Positive affect	120	2.00	6.00	3.92	1.05
Negative effect	120	1.00	4.40	1.65	0.77
Medication administration error rate	64	0.00	1.00	0.14	0.31

Task completion rate. On average, nurses planned to complete 3.43 tasks per care episode. However, in actuality, nurses completed an average of 3.64 tasks per care episode, meaning they completed more tasks than they had intended. This resulted in an average task completion rate of 119% (*SD* = 0.73), ranging from accomplishing 0% of their tasks to accomplishing 600% of their tasks (see Conclusion for a discussion of this finding). Table 7 shows average planned tasks compared to average completed tasks for each care episode.

Table 7

Planned Versus Completed Tasks

Episode no.	Average tasks: Planned	Average tasks: Completed
1	4.45	4.80
2	4.50	4.35
3	3.30	3.75
4	2.45	2.70
5	3.40	3.70
6	2.50	2.55
Grand mean	3.43	3.64

MAE rate. Medication administration error rates were low. Of the 120 episodes of patient care observed, only 64 involved medications being administered. Of those 64 administered doses, 12.5% involved an administration error of some kind. Of the approximately eight medication errors, half (4) were timing errors which were not considered to be clinically significant when reviewed by the nurse coordinator for the unit. The remaining four errors were errors of omission and at the time of chart review could not be validated by the nurse coordinator as being clinically significant because of outstanding questions about the original orders. Given the low variation of MAEs, MAE rate was not considered to be a viable dependent variable, and no further analysis of this variable was conducted.

Perceived stress, positive affect, and negative affect. Nurses, on average, perceived relatively low levels of stress (M = 2.11, SD = 0.90), had a moderately positive affect (M = 3.92, SD = 1.05), and had low negative affect (M = 1.65, SD = 0.77).

Internal consistency of episode-level scales. For perceived stress, positive affect, and negative affect, internal consistency was assessed. As with the nurse-level variables, the episode-level within person reliability was calculated using correlations. Episode-level items were within-person centered (i.e., centered around each person's individual mean) to remove variance attributable to the between-person (i.e., nurse-level) of analysis. Perceived stress (correlation = 0.606), positive affect (correlation = 0.676), and negative affect (correlation = 0.713) all had less than ideal levels off internal consistency. While, these internal consistency levels are a clear limitation of this study, correlations at or above 0.60 have been noted to be acceptable in previous literature (van Griethuijsen et al., 2015; DeVellis, 1991). Estimated within person reliability for each episode-level scale is reported in Table 8.

Table 8

Summary of Episode-Level Scale Reliability

	No. items	*n*	α	*SD* α
Perceived stress	4	117	0.606	0.702
Positive affect	4	120	0.676	0.677
Negative affect	5	119	0.713	0.688

Interitem Correlations of All Variables

Table 9 shows interitem correlations of all scale items on the nurse questionnaire and episodic surveys. Both between-individual and within-individual correlations for variables 11 to 16 in Table 9 are reported. Correlations for episode-level (Level-1) variables reflect within-

Table 9

Descriptive Statistics and Correlations Among Between-Person Variables and Aggregated Within-Person Variables

	Mean	***SD***	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Nurse-level variables:													
1. Education	3.00	0.32	--										
2. Unit tenure	3.65	1.18	.55*	--									
3. Nurse tenure	3.75	1.07	.61**	.89**	--								
4. Age	28.70	5.59	0.15	.55*	.62**	--							
5. Race	1.50	1.24	0.00	-0.20	-0.22	-0.41	--						
6. Ethnicity	1.90	0.31	0.00	0.33	0.40	0.20	-0.42	--					
7. Gender	1.85	0.37	0.00	0.12	0.17	-0.31	0.17	0.33	--				
8. Conscientiousness	5.20	0.53	-0.03	‘-0.06	-0.10	0.06	0.06	-0.19	-0.08	--			
9. Stress mindset	3.59	0.84	-0.17	-0.33	0.35	-0.21	0.26	-0.29	-0.12	0.12	--		
10. Psychological resilience	5.19	0.46	-0.41	-0.22	-0.31	-0.14	0.13	-0.17	0.08	.59**	.58**	--	
Episode-level variables:													
11. Task completion rate	1.19	0.33	-0.12	-0.10	-0.08	0.04	-0.08	0.07	0.17	-0.25	0.22	0.06	--
12. Perceived stress	2.11	0.71	0.02	-0.17	-0.32	-0.12	0.05	-0.06	-0.15	-0.30	-0.14	-0.14	0.37
13. Positive affect	3.92	1.00	-0.08	-0.23	-0.08	0.11	0.09	-0.30	-0.16	.461*	0.33	0.42	-0.02
14. Negative affect	1.65	0.65	-0.01	0.00	-0.10	0.21	0.10	0.10	-0.35	-0.31	0.22	0.02	-0.02
15. Room-type	1.58	0.36	-0.15	-0.08	-0.24	-0.22	-0.01	0.15	-0.31	0.02	-0.16	-0.04	-0.06
16. Interruptions	2.43	1.53	0.11	-0.35	-0.27	0.18	-0.25	-0.20	-.50*	0.08	0.09	-0.13	0.01

Episode-level variables (cont.)	**Mean**	***SD***	**12**	**13**	**14**	**15**	**16**
12. Perceived stress	2.11	0.71	--	-.45**	.58**	0.04	.31***
13. Positive affect	3.92	1.00	-0.35	--	.43**	-0.06	-0.17
14. Negative affect	1.65	0.65	.68**	-0.27	--	-0.10	.31**
15. Room-type	1.58	0.36	0.28	-0.09	0.21	--	.18*
16. Interruptions	2.43	1.53	0.27	0.31	0.28	0.24	--

*$p < .05$, **$p < .01$, ***$p < .001$.

person centered relationships and are presented above the diagonal (n = 120). Episode-level (Level-1) variables were aggregated (i.e., summarized by calculating the mean via IBM SPSS Statistics 25® software) to estimate between-individual (Level-2) correlation and are presented below the diagonal (n = 20). Nondirectional two-tailed tests were used to test for significant relationships and the $p < 0.5$ level.

For the variables of interest, findings indicate significant positive correlation between psychological resilience and conscientiousness (r =.59, p <.01), psychological resilience and stress mindset (r =.58, p <.01), positive affect and conscientiousness (r =.461, p <.05), perceived stress and negative affect (r =.58, p <.01), perceived stress and interruptions (r =.31, p <.01), negative affect and interruptions (r =.31, p <.01), and room-type and interruptions (r =.18, p <.05). Findings indicate a significant negative correlation between positive affect and negative affect (r = -.43, p <.05). These bivariate correlations are helpful in beginning to understand the underlying relationships amongst the variables in the study. However, mediation models and moderated mediation models reveal more about the inclusion of multiple variables in the model and their relationship to one another.

Episode-Level Variance

Before conducting further analysis, a series of null models was run to confirm that there was sufficient within-person variance for the episode-level variables. To continue with multilevel analysis, sufficient (>10%) percentage of within-individual variance must be present. This analysis of percentage of variance was conducted using MPlus® software. Episode- and nurse-level variances were extracted for each episode-level measure. Percentage of within-person variance at the episode-level was computed using the following formula: $\sigma^2/(\sigma^2 + \tau_{00})$,

where σ^2 represents within-individual variance (based on average repeated measures for each individual nurse) and τ_{00} represents between-individual variance (based on measures across all nurses). Table 10 displays sufficient episode-level variance to continue with multilevel analysis.

Table 10

Percentage of Within-Individual Variance Among Episode-Level Variables

	Within-individual variance (*a2*)	Between-individual variance (*r00*)	(%) Within-individual variance
Perceived stress	0.379	0.42	47
Positive affect	0.163	0.93	15
Negative affect	0.218	0.37	37
Task completion	0.494	0.039	93
Room-type	0.145	0.099	59
Interruptions	15.618	0.755	95

Differences in Interruptions by Room-Type

Research Question 1 asks, does frequency of interruptions differ by patient room type and tests H_1: Nurses providing care in DO rooms will experience more interruptions than when providing care in SO rooms. To test H_1, a Mann-Whitney U test was run to determine if there were differences in interruptions between SO and DO room-types. Interruptions data were not normally distributed, thus failed to meet the normal distribution assumptions of the independent-samples *t*-test (Dineen & Blakesley, 1973). Therefore, the Mann-Whitney U test was used as a nonparametric alternative to an independent-samples *t*-test. Frequency of interruptions was statistically significantly higher in DOs (Median = 2) when compared to SOs (Median = 1), U = 2,132.5, z = 2.026, p = .043.

Mediating Effect of Room-Type

Research Question 2 asks, does room-type mediate the relationship between interruptions and (H_2) task completion, (H_4) perceived stress, and experience of (H_5) positive and (H_6) negative affect? In testing these hypotheses, I modeled task completion, perceived stress, positive affect, and negative affect as separate dependent variables. Room-type was entered as the independent variable and interruptions was entered as the mediator. Because of the low sample size and resulting statistical power, I was not able to include preshift affect (positive or negative) or preshift stress as covariates.

Figure 9 illustrates the bivariate relationships of the random coefficient models of the mediation tests for H_2-H_6[4]. It displays the parameter estimate and standard error of each relationship and indicates where statistically significant relationships were found. Table 11 displays the parameter estimates of the mediation effect, standard error, p-value, and confidence interval for H_2-H_6.

H2. H2 was partially supported. The random coefficient model for H_3, tests the statistical significance of bivariate relationships with interruptions mediating the effect of room-type on task rate. The path indicating room-type as a predictor of interruptions was significant, where interruptions increase in DO rooms compared to SO rooms ($\gamma = 1.37$, SE = 0.7, $p = .05$).

A significant direct effect was also found ($\gamma = 0.38$, SE=0.17, $p = .03$), indicating that task completion rate was higher in DO rooms compared to SO. Interruptions did not have a significant effect on task rate ($\gamma = 0.01$, SE = 0.01, $p = 0.71$. Finally, to test for the overall

[4] H3 was not tested due to low variance of medication administration errors.

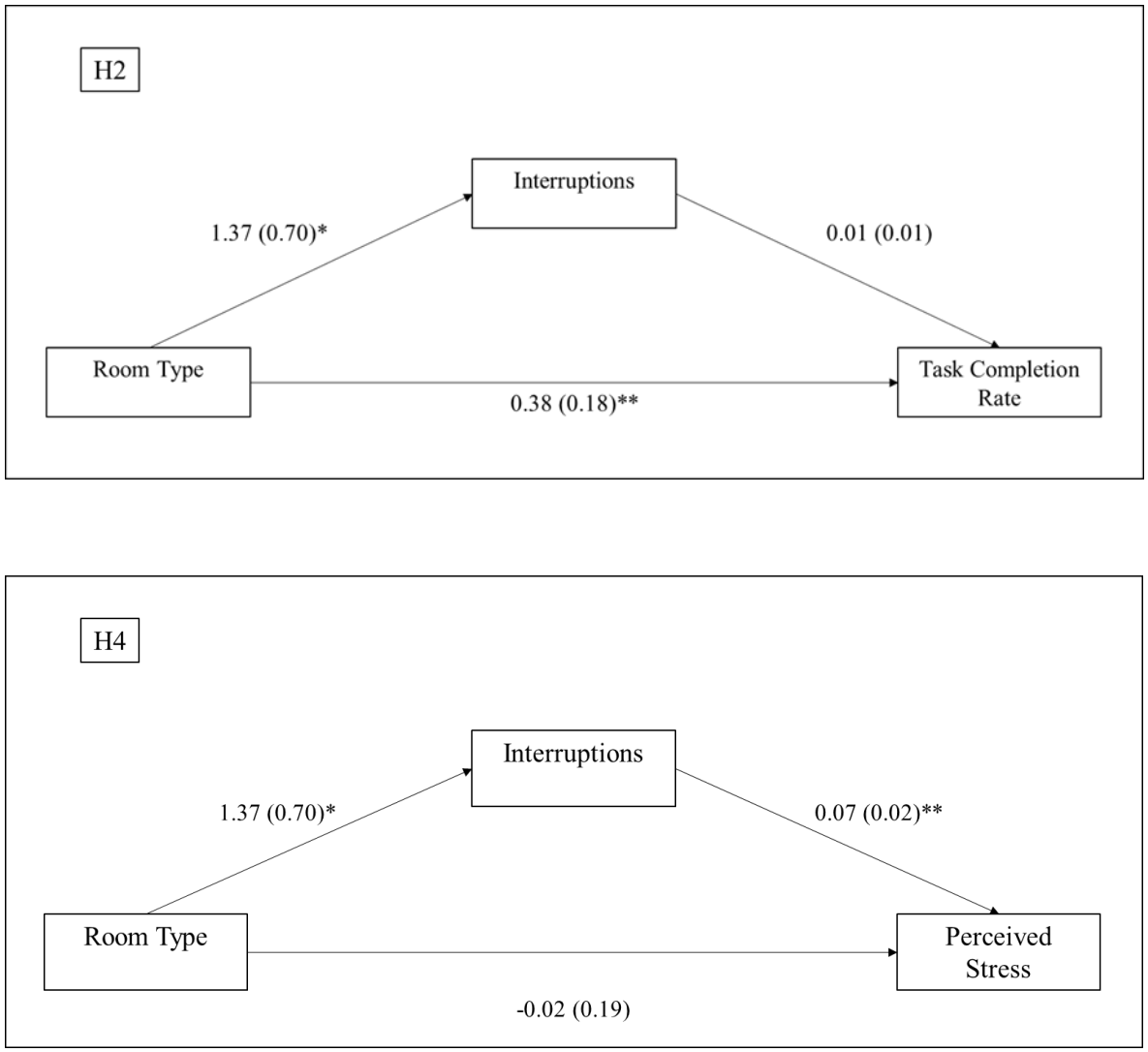
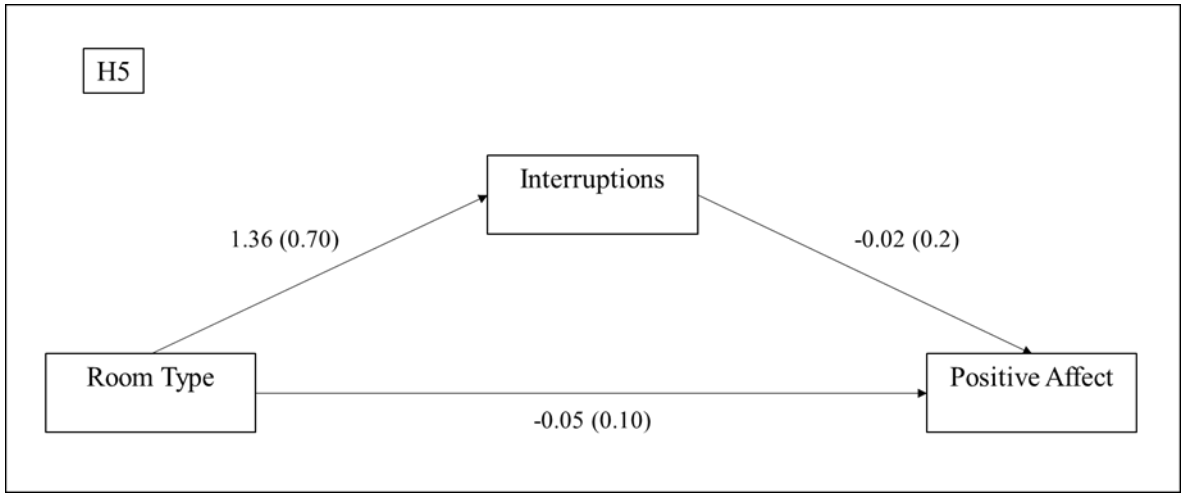


Figure 9. Random coefficient mediation models for H2, H2, H4, H5, and H6, (n = 120). Values in parenthesis are standard errors. *p < .05, **p < .01



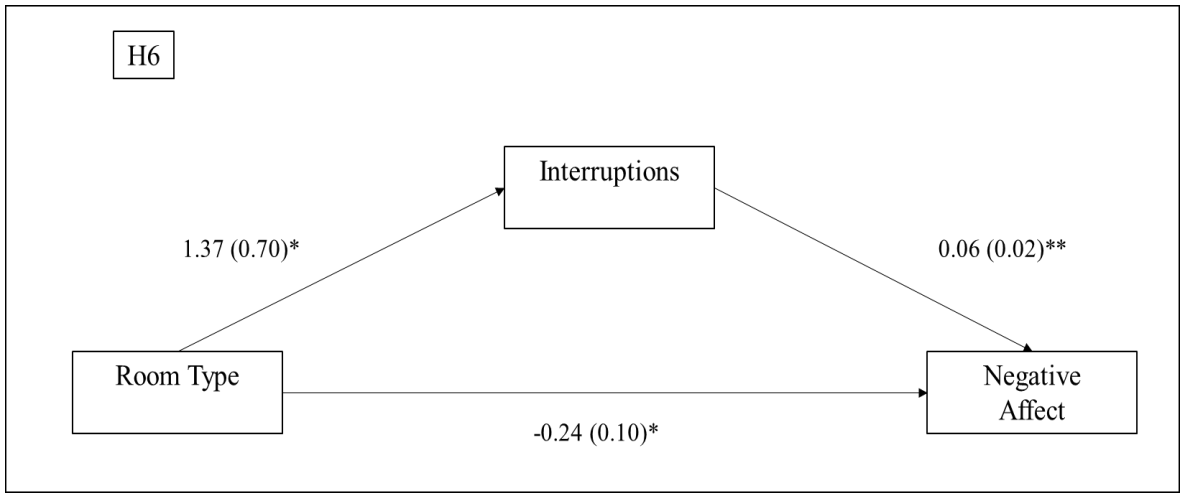


Figure 9 (continued). Values in parenthesis are standard errors. *p < .05, **p < .01

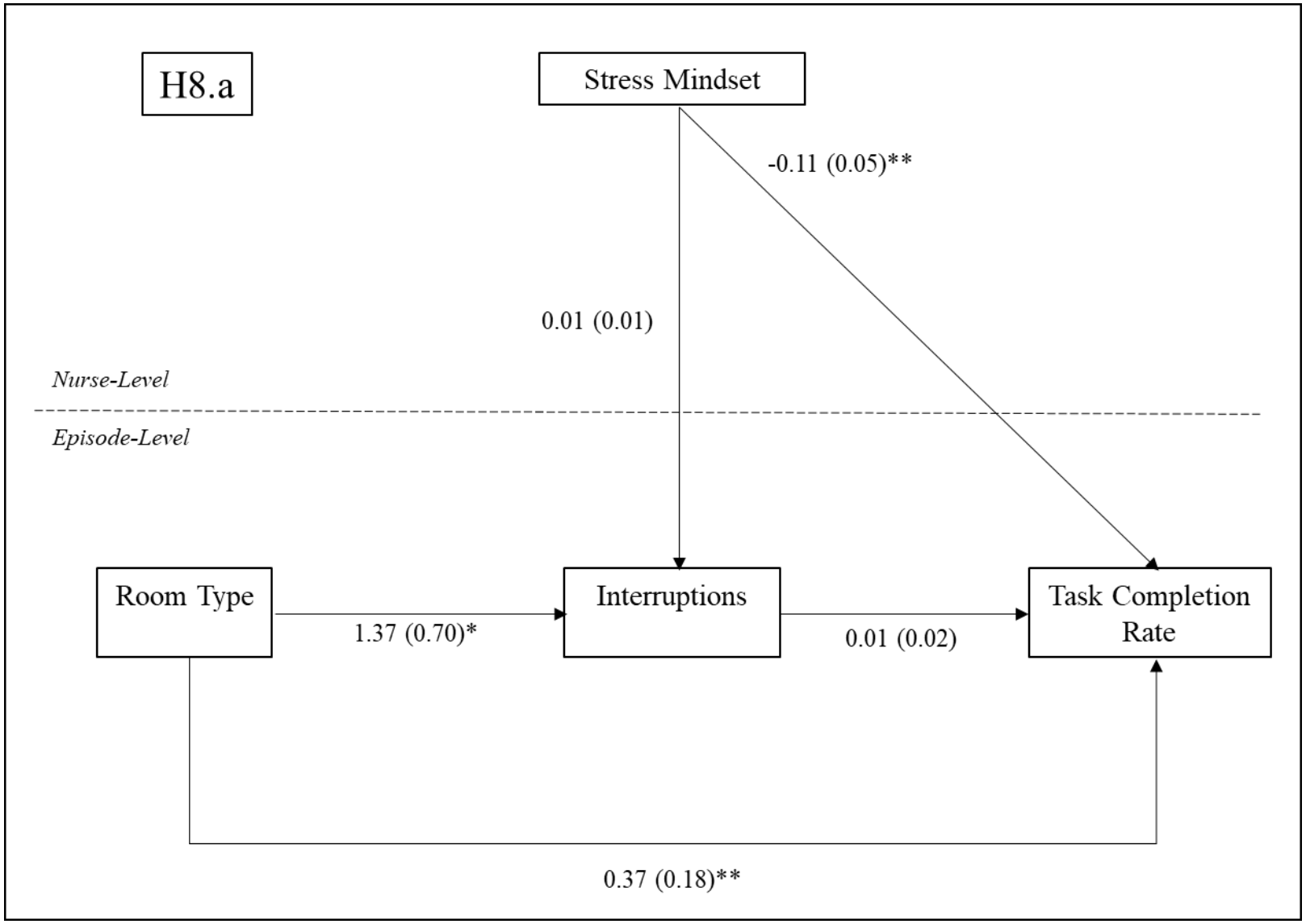


Figure 9 (continued)

Table 11

Mediation Effect of Random Coefficient Models (N = 120)

				95% confidence interval*	
	Estimate	SE	*p*-value	Lower 0.5%	Upper .5%
H2. Task rate	0.01	0.02	0.71	-0.0400	0.0469
H4. Perceived stress	0.94	0.7	0.16	0.0002	0.2606
H5. Positive affect	-0.02	0.03	0.44	-0.0910	0.0215
H6. Negative affect	0.08	0.04	0.09	-0.0029	0.1767

*Medication effect considered significant when 95% confidence interval range does not include 0.

mediation affect, bootstrap confidence intervals via the MCMAM indicate that interruptions do not mediate the effect of room-type on interruptions (estimate = 0.01, SE = 0.02, 95% CI [-0.0400, 0.04696]).

H4. The random coefficient model for H4 tests the statistical significance of bivariate relationships with interruptions mediating the effect of room-type on perceived stress. Room-type was a significant predictor of interruptions, where interruptions increase in DO rooms compared to SO rooms ($\gamma = 1.37$, SE = 0.70, $p = .051$). The direct effect of room-type on perceived stress was nonsignificant ($\gamma = -0.02$, SE = 0.19, $p = 0.94$). Interruptions also had a significant effect on perceived stress ($\gamma = 0.07$, SE = 0.02, $p = 0.002$). Finally, to test for the overall mediation affect, bootstrap confidence intervals via the MCMAM, only H4 was fully supported (estimate = 0.94, SE = 0.07, 95% CI [0.0002, 0.2606]). This indicates that interruptions mediate the effect of room-type on perceived stress. In other words, perceived stress was an effect of room-type that was transmitted through frequency of interruptions.

H5. H5 was not supported. The random coefficient model for H5, tests the statistical significance of bivariate relationships with interruptions mediating the effect of room-type on positive affect. In this model, the path indicating room-type as a predictor of interruptions was

marginally significant (γ = 1.36, SE = 0.7, *p* =0.52). Room-type did not have a significant direct effect on positive affect (γ = -0.05, SE=0.10, *p* = .0.58. Nor did interruptions have a significant effect on positive affect (γ = -0.02, SE = 0.2, *p* = 0.37. Finally, to test for the overall mediation affect, bootstrap confidence intervals via the MCMAM indicate that interruptions do not mediate the effect of room-type on interruptions (estimate = -0.02, SE = 0.03, 95% CI [-0.0910, 0.0215).

H6. H6 was partially supported. The random coefficient model for H6, tests the statistical significance of bivariate relationships with interruptions mediating the effect of room-type on negative affect. I n this model, the path indicating room-type as a predictor of interruptions was marginally significant (γ = 1.36, SE = 0.7, *p* =0.51). Room-type had a significant direct effect on negative affect (γ = -0.24, SE = 0.10, *p* = 0.02), with lower levels of negative affect in DO rooms when compared to SO rooms. This was also the opposite direction of what was hypothesized in H6 (See Conclusion for discussion of this finding). Interruptions had a significant effect on negative affect (γ = 0.06, SE = 0.2, *p* = 0.006). Finally, to test for the overall mediation affect, bootstrap confidence intervals via the MCMAM indicate that interruptions do not mediate the effect of room-type on interruptions (estimate = 0.08, SE = 0.04, 95% CI [-0. 0029, 0. 1767).

Lasting Effects of Interruptions

Research Question 3 asks if a single care episode's outcome affects the outcomes of subsequent episodes. To answer this question, H7 posited that the mediating effect of interruptions on task completion rate, MAEs, perceived stress, positive affect, and negative affect occurring during a patient episode would further contribute to subsequent (a) task completion rate, (b) MAEs, (c) perceived stress, (d) positive affect, and (e) negative affect in subsequent care

episodes. The sample size of 120 observations did not yield enough statistical power to test this hypothesis. Thus, H7 was not tested.

Moderating Effects of Intrapersonal Resources

Research Question 4 asks: Do certain intrapersonal resources of nurses, operationalized as stress mindset (H8), conscientiousness (H9), and psychological resilience (H10) mitigate the negative effects of interruptions? The simultaneous path analysis that was planned could not be conducted due to insufficient sample size and statistical power. Instead, the hypothesized moderators (stress mindset, psychological resilience, and conscientiousness) were separately entered as cross-level moderators for each dependent variable, resulting in 12 separate multilevel moderated mediation models. In testing these hypotheses, I again modeled task completion rate, perceived stress, positive affect, and negative affect as separate dependent variables. Room type was entered as the independent variable and interruptions was entered as the mediator. Again, because of the low sample size, I was not able to include preshift affect (positive or negative) or preshift stress as covariates.

Figures 10, 11, and 12 illustrate the bivariate relationships of the random coefficient models of the moderated mediation tests for H8-H10[5]. They display the parameter estimate and standard error of each relationship and indicate where statistically significant relationships were found. Tables 12-14 display the results of the 12 multilevel moderated mediation random modes (H8-H10), with dependent variables presented according to each moderator.

H8a. The multilevel moderated mediation random coefficient model for H8a, where interruptions are hypothesized to mediate the effect of room-type on task completion rate, and stress mindset is hypothesized to moderate that effect, was not supported. The path indicating room-type as a predictor of interruptions was marginally significant, where interruptions increase

[5] H8b, H9b, and H10b were not tested due to low variance of medication administration errors.

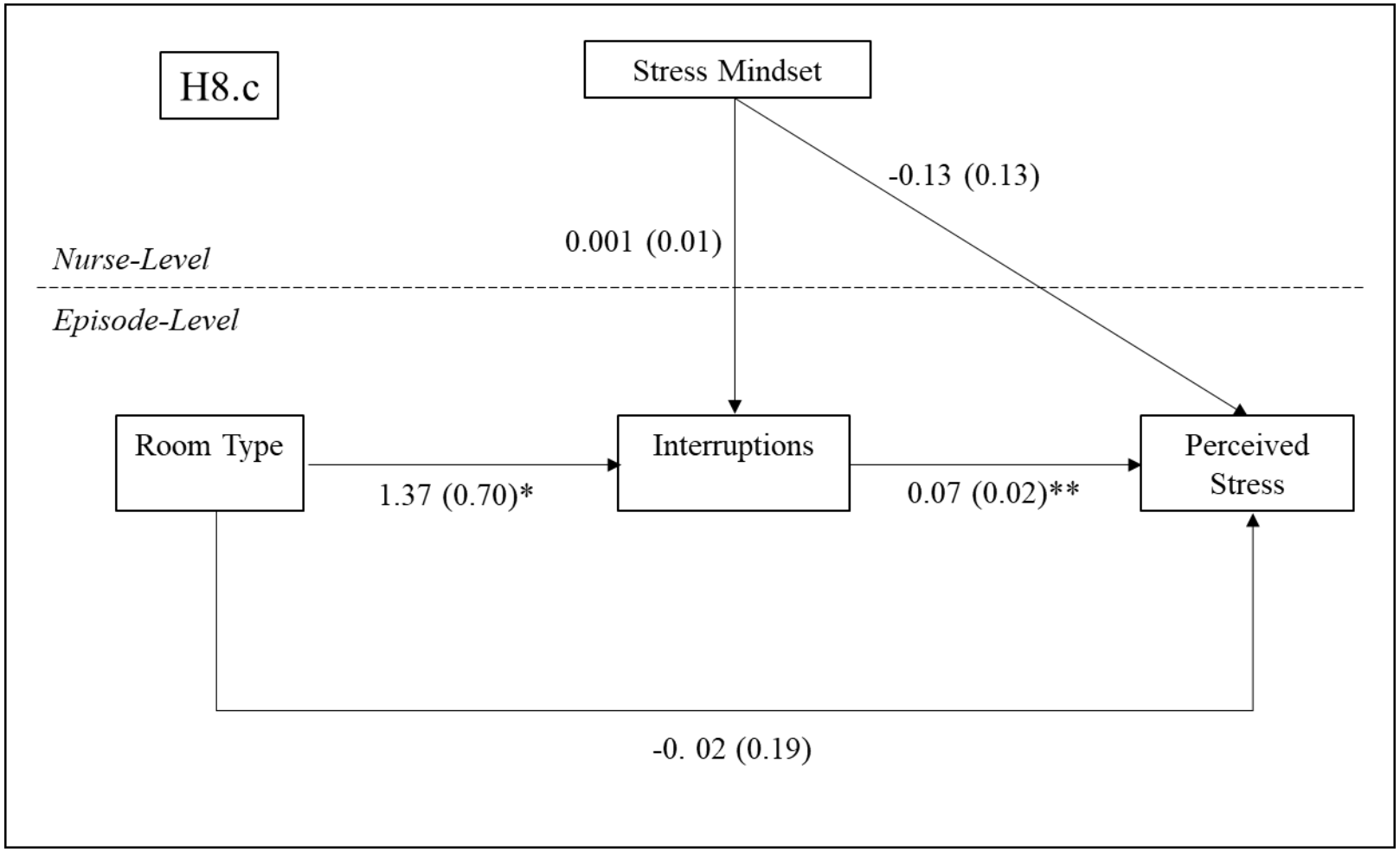


Figure 10. Random coefficient moderated mediation models for H8a-e, (*n* = 120). Values in parenthesis are standard errors. *$p < .05$, **$p < .01$.

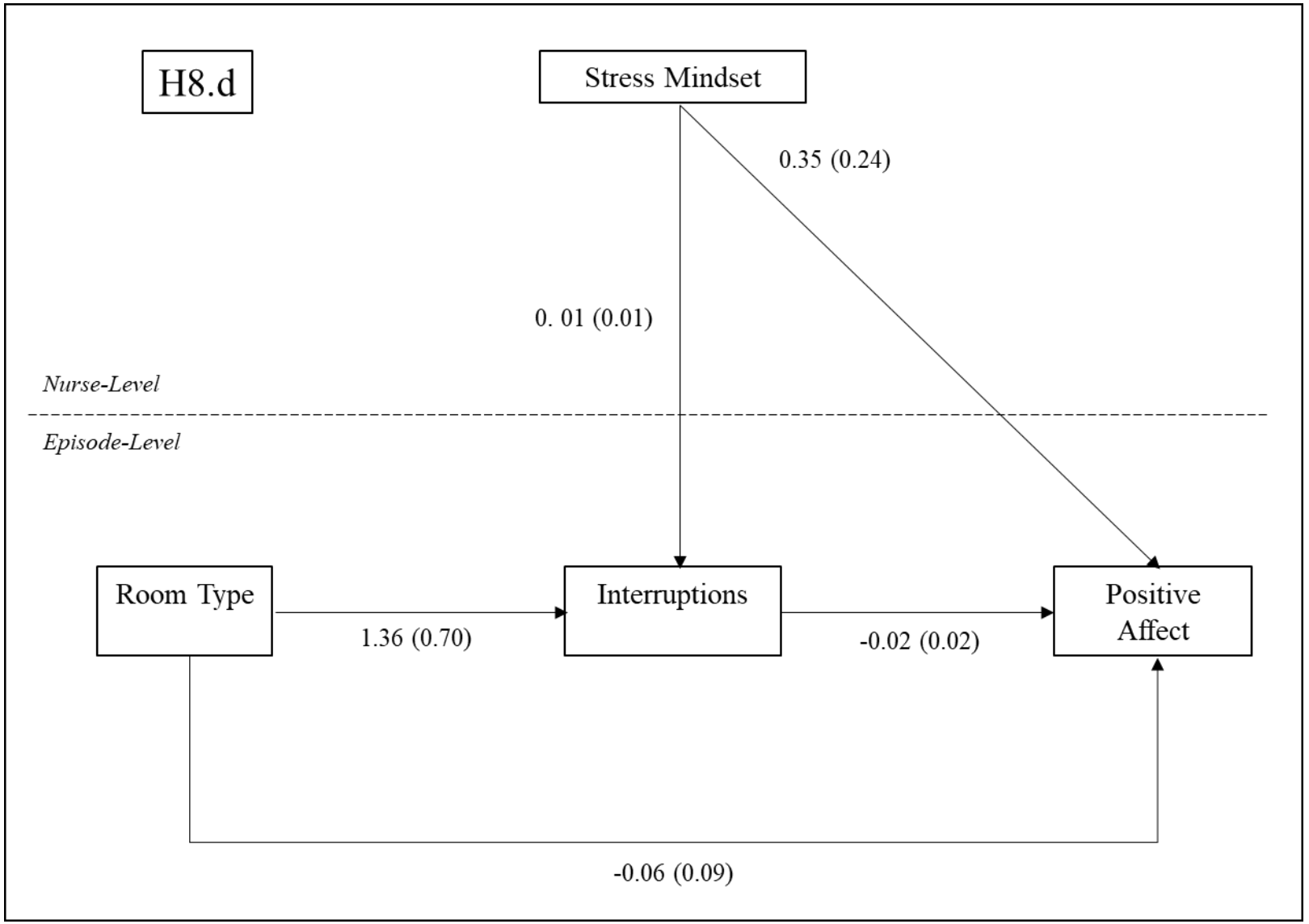


Figure 10 (continued). Values in parenthesis are standard errors. *$p < .05$, **$p < .01$.

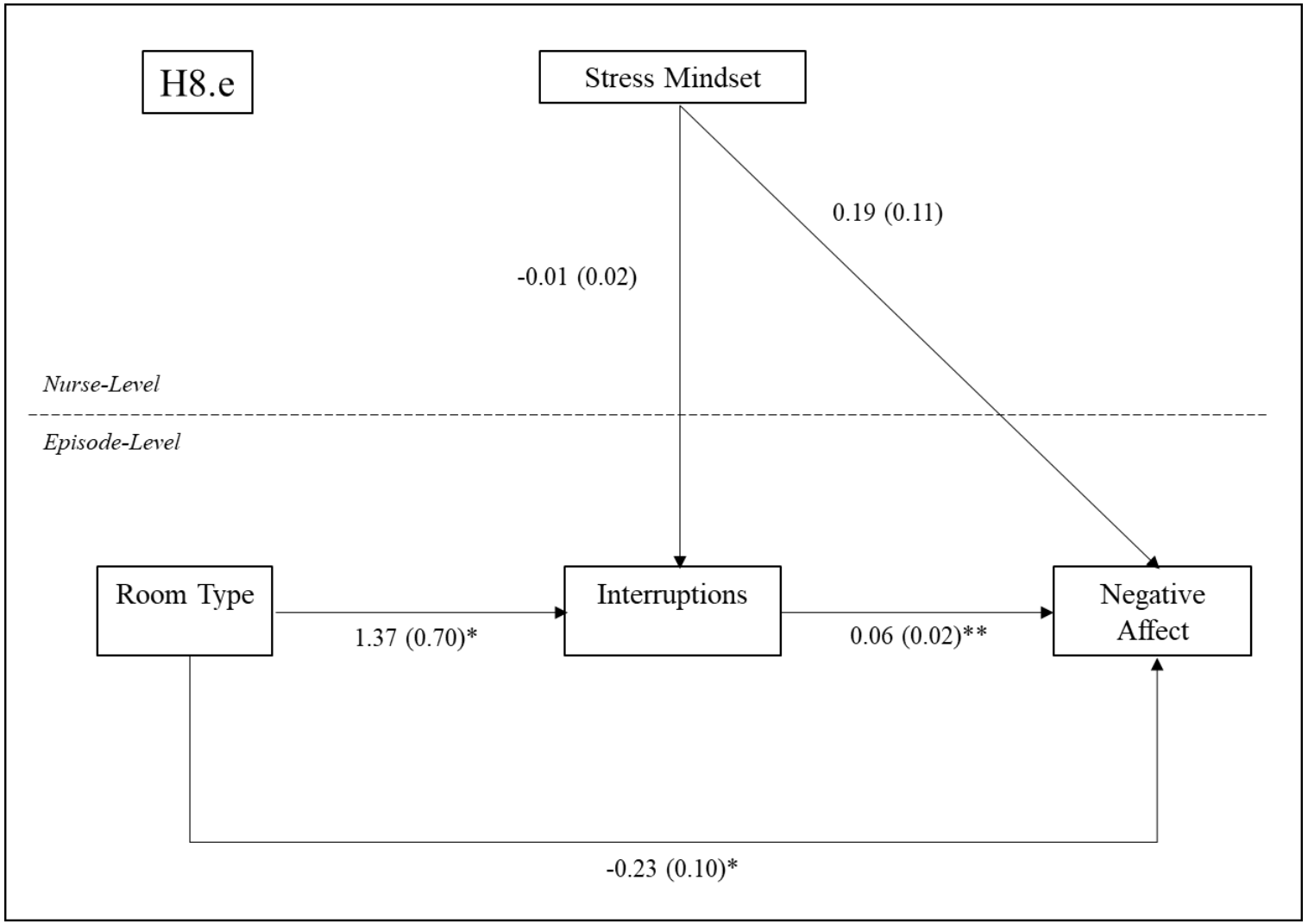


Figure 10 (continued). Values in parenthesis are standard errors. *$p < .05$, **$p < .01$.

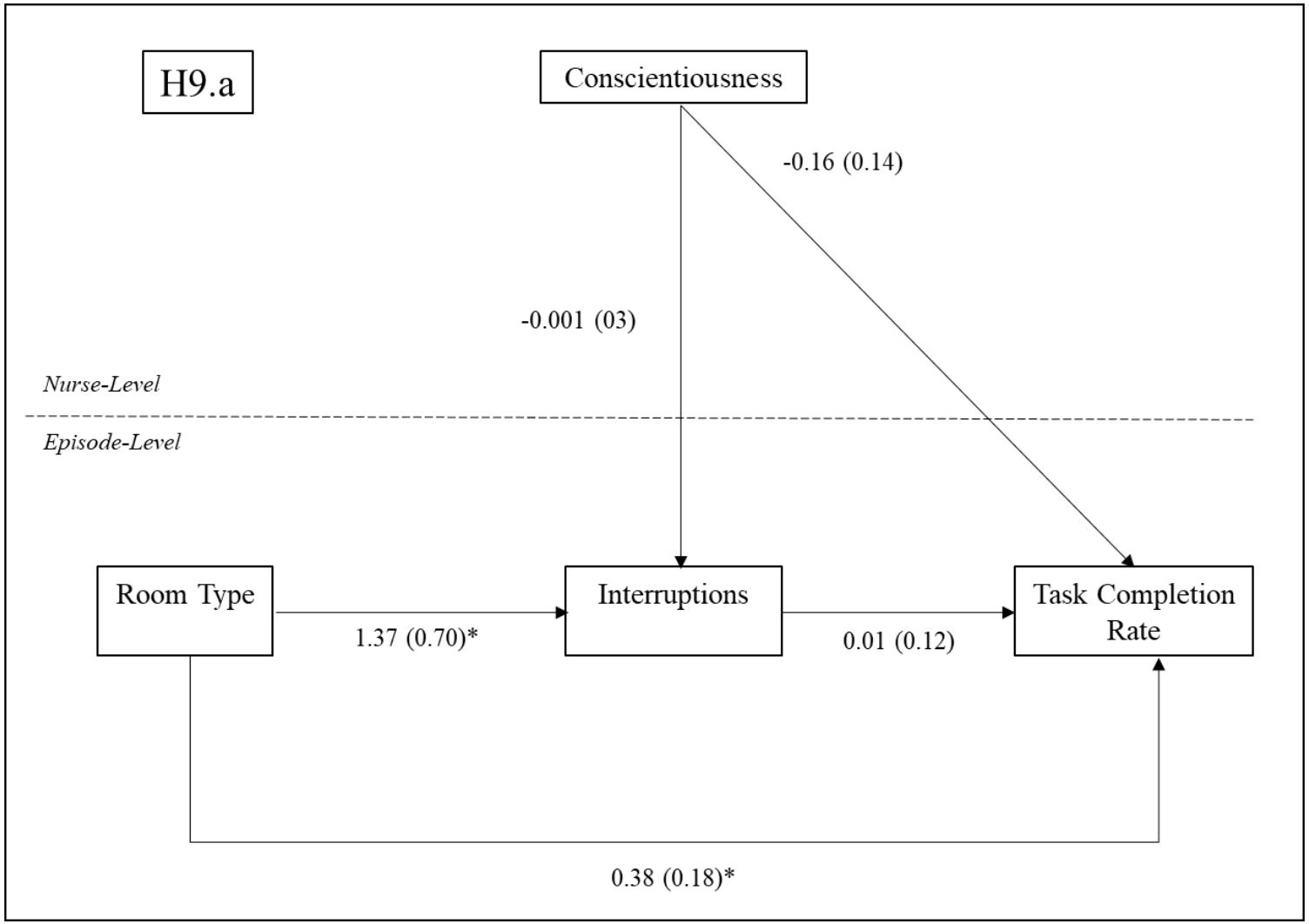


Figure 11. Random coefficient moderated models for H9, $n = 120$. Values in parenthesis are standard errors. $^{*}p < .05$, $^{**}p < .01$.

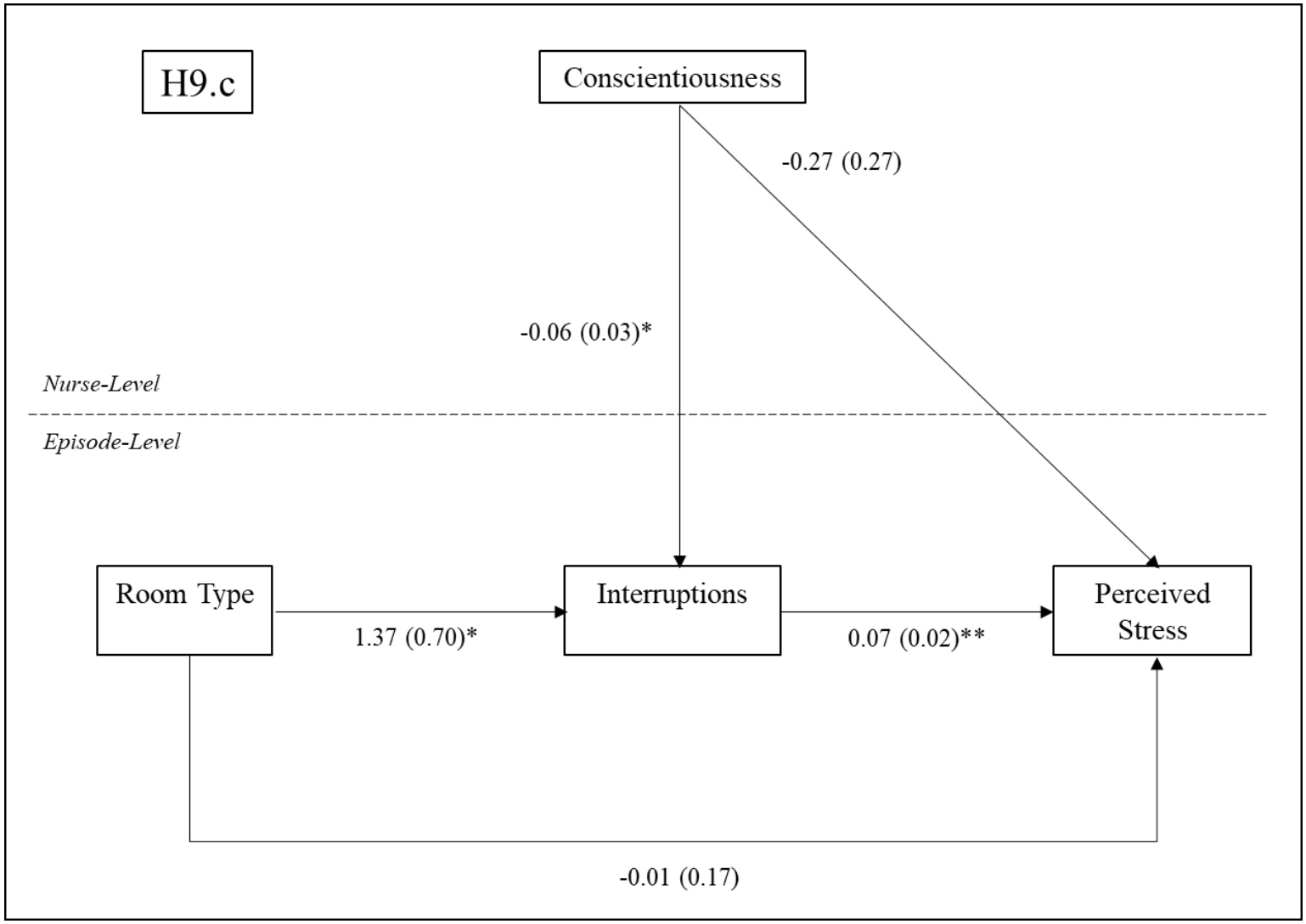


Figure 11 (continued). Values in parenthesis are standard errors. *$p < .05$, **$p < .01$.

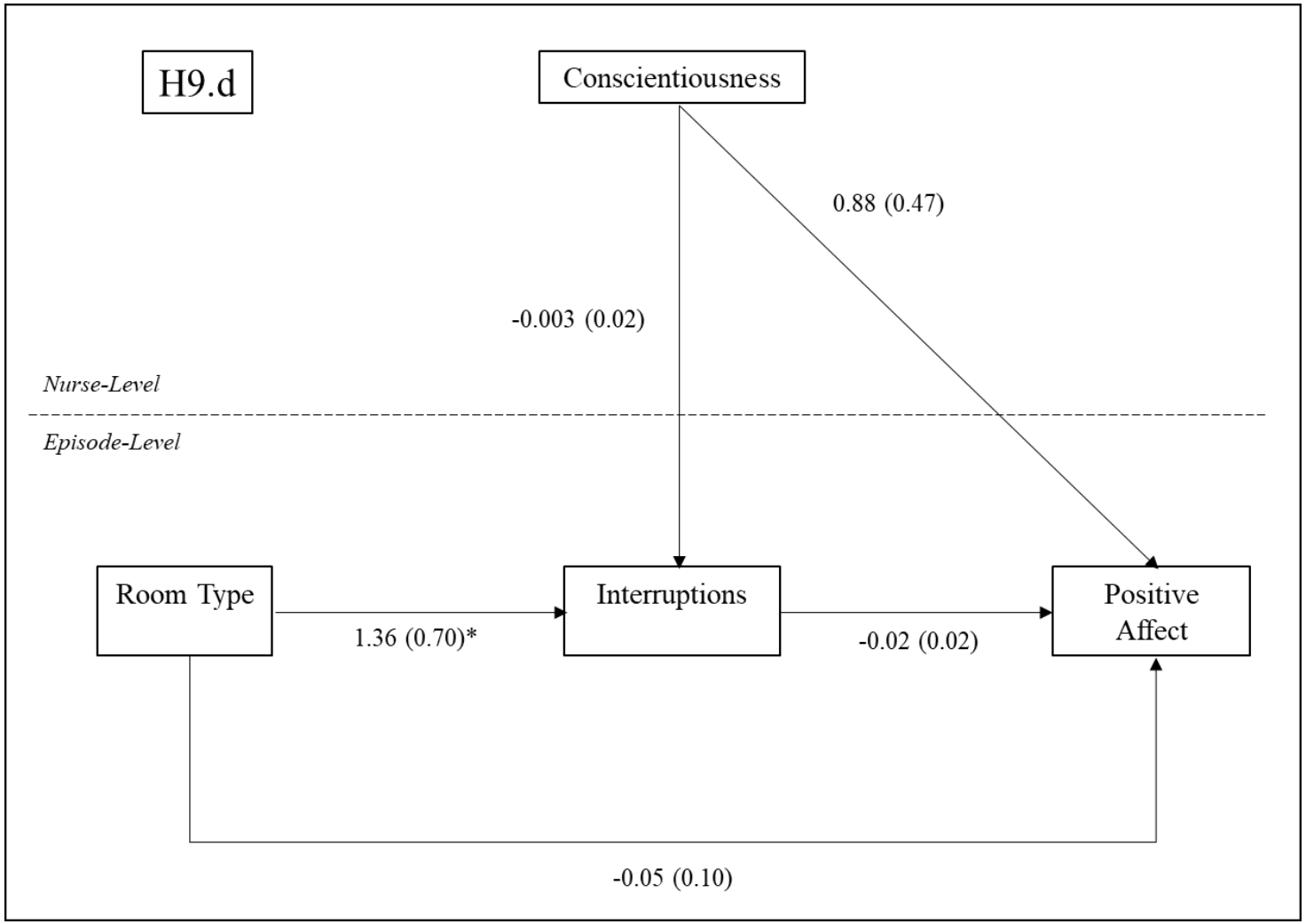


Figure 11 (continued). Values in parenthesis are standard errors. *$p < .05$, **$p < .01$.

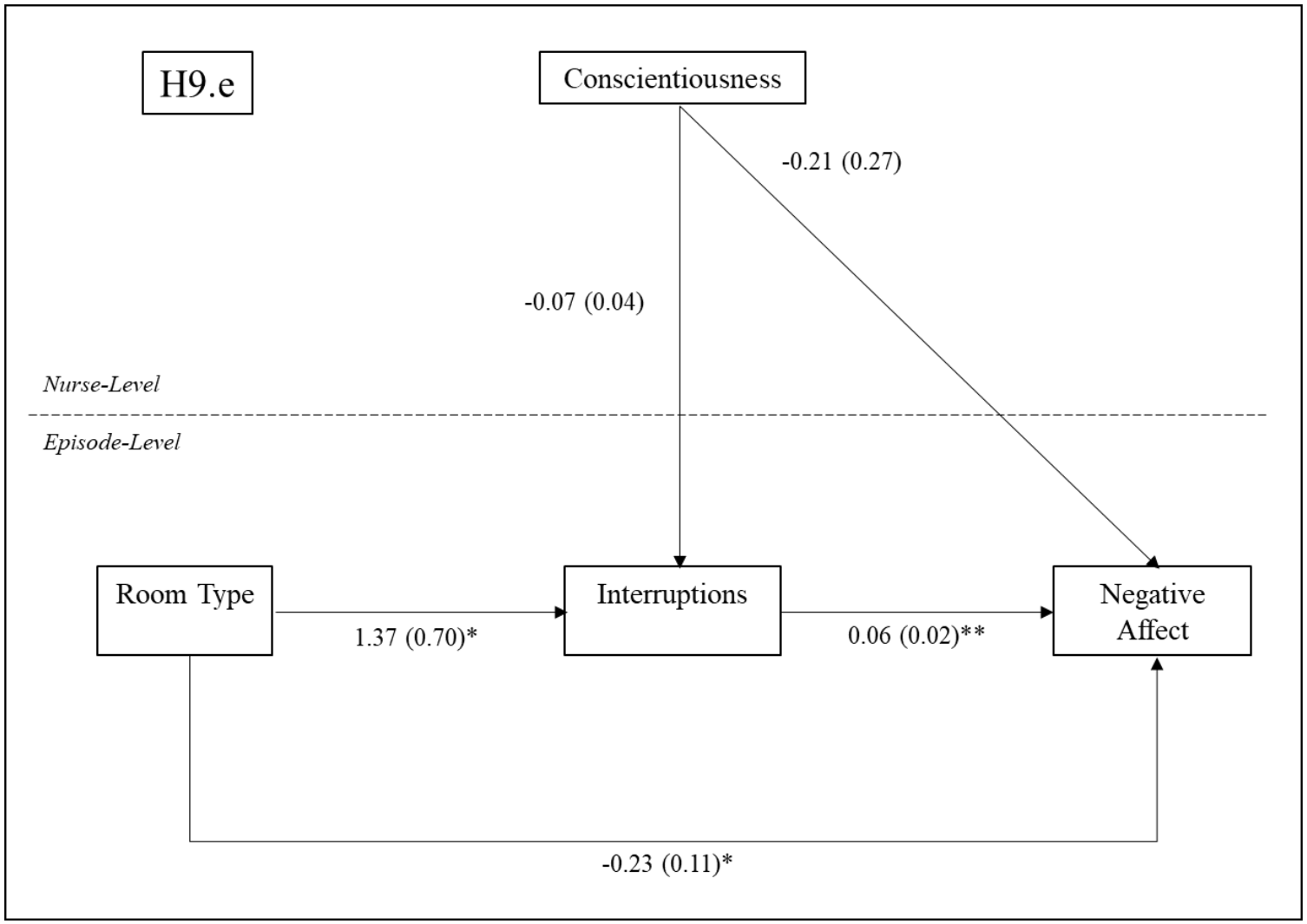


Figure 11 (continued). Values in parenthesis are standard errors. *$p < .05$, **$p < .01$.

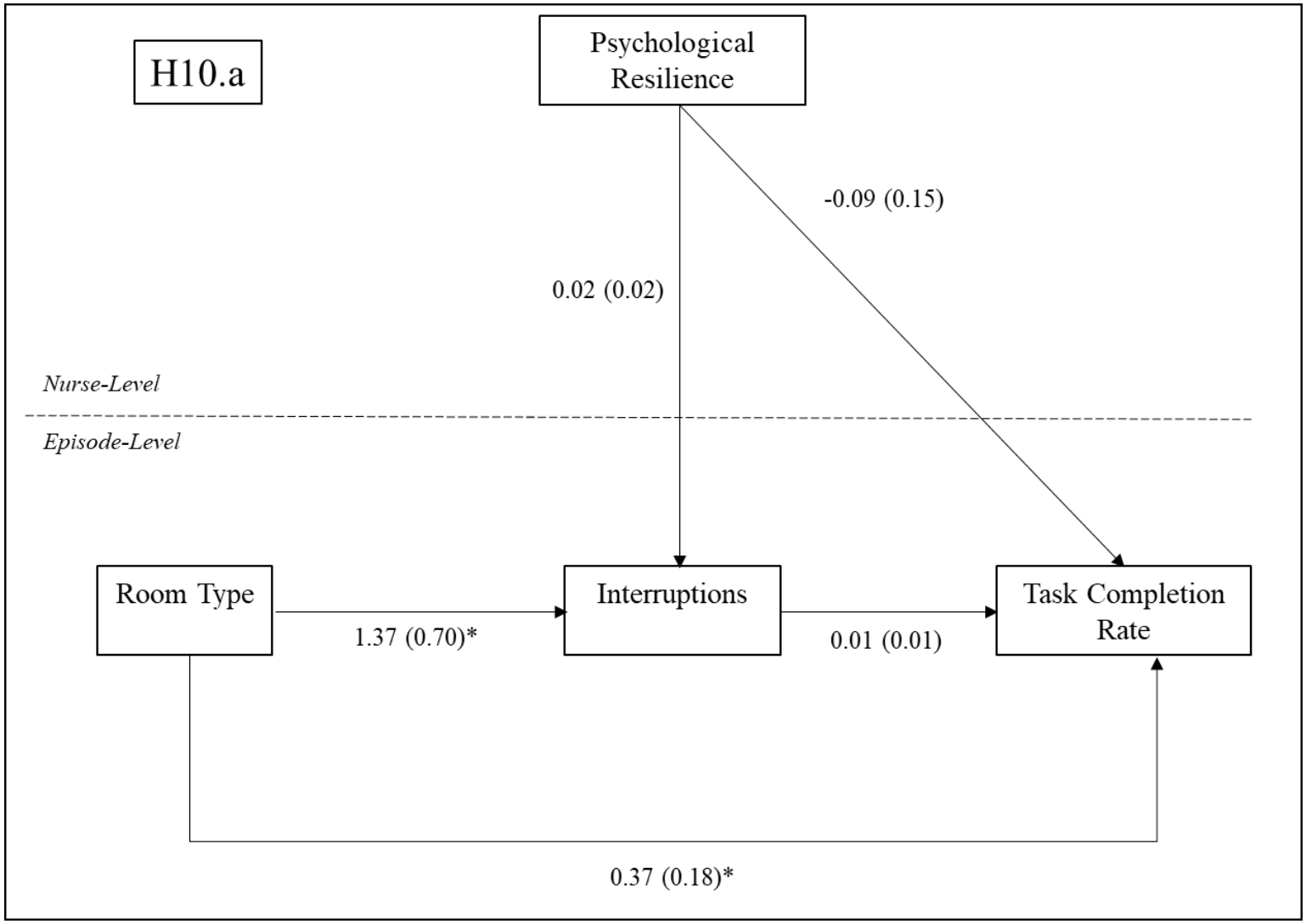


Figure 12. Random coefficient moderated mediation models for H10 (n = 120). Values in parenthesis are standard errors. *p < .05, **p < .01.

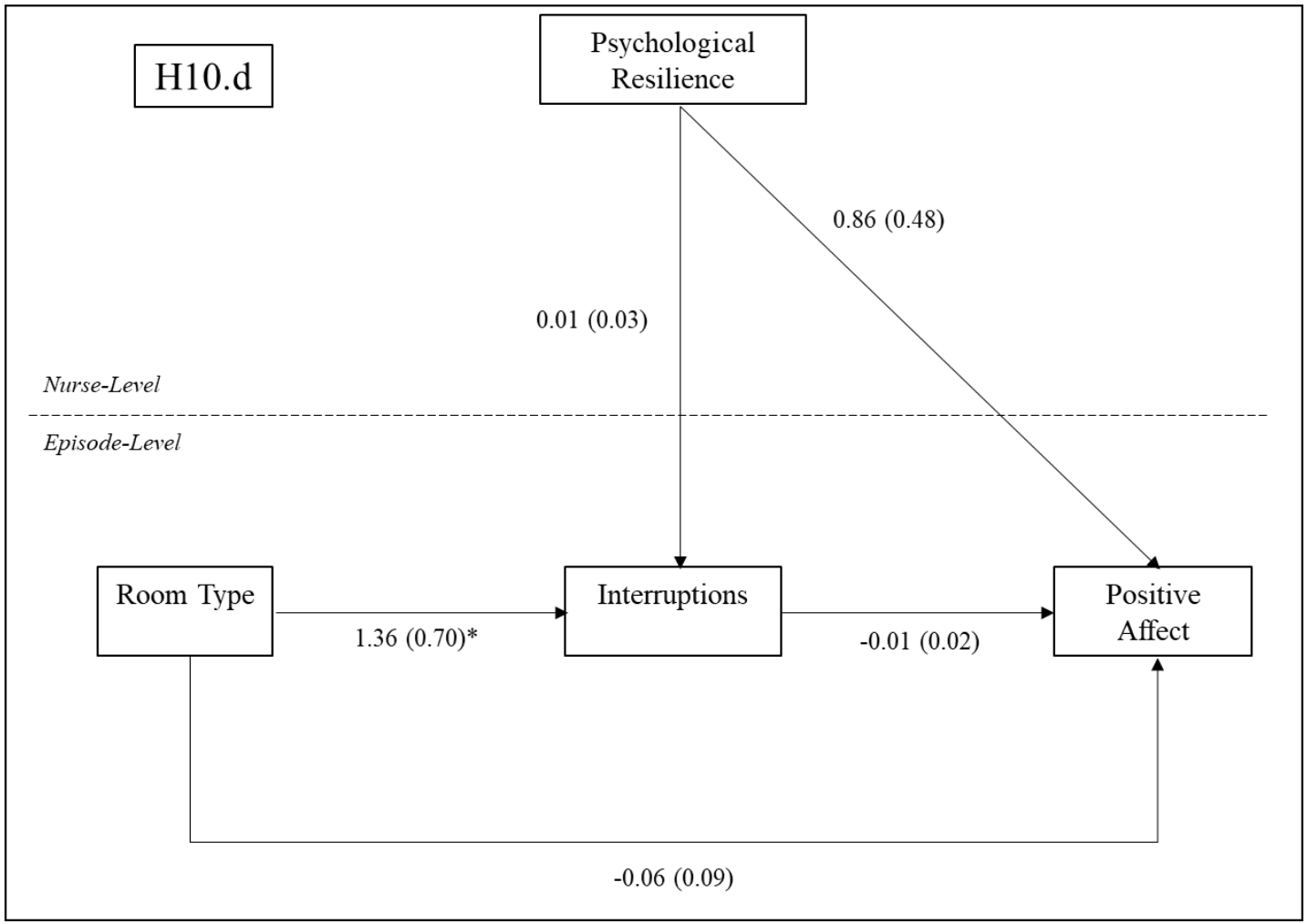


Figure 12 (continued). Values in parenthesis are standard errors. *$p < .05$, **$p < .01$.

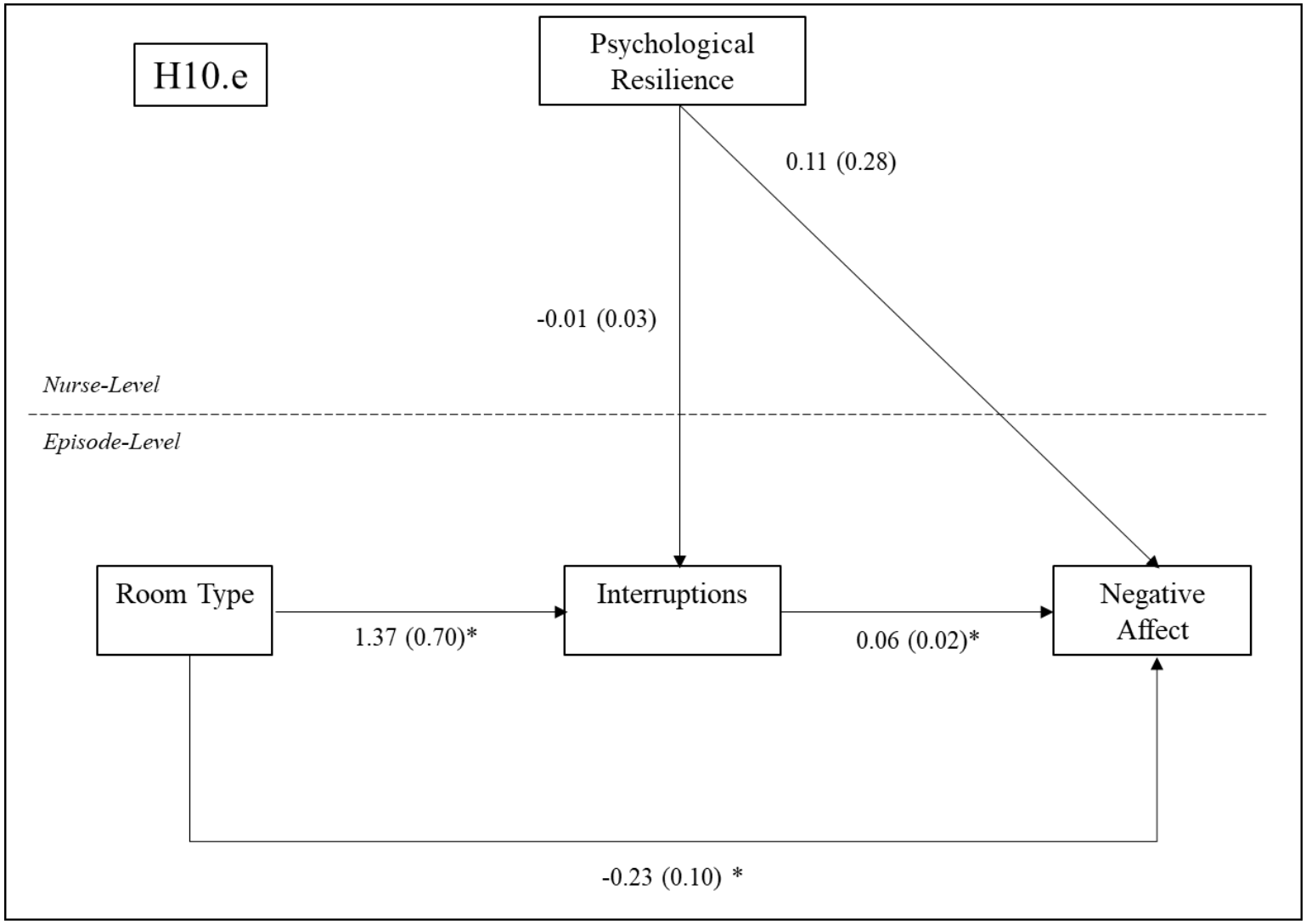


Figure 12 (continued). Values in parenthesis are standard errors. *$p < .05$, **$p < .01$.

Table 12

Multilevel Moderated Mediation Random Coefficient Models: Stress Mindset

	Task completion rate (H8.a)	Perceived stress (H8.c	Positive affect (H8.d)	Negative affect (H8.e)
Predictors:				
Intercept	1.18 (0.08)	1.94 (0.14)	3.95 (0.21)	1.53 (0.13)
Level-1				
Room-type	0.37 (0.18)*	-0.02 (0.19)	-0.06 (0.09)	-0.23 (0.10)**
Interruptions	0.01	0.07 (0.02)*	-0.02 (0.02)	0.06 (0.02)*
Cross-level				
Stress mindset	-0.11 (0.05)*	-0.13 (0.13)	0.35 (0.25)	0.19 (0.12)
Stress mindset x Interruptions	0.01 (0.01)	0.001 (0.01)	0.01 (0.01)	-0.01 (0.02)

*p < 05, **p < .001

Table 13

Multilevel Moderated Mediation Random Coefficient Models: Conscientiousness

	Task completion rate (H9.a)	Perceived stress (H9.c)	Positive affect (H9.d)	Negative affect (H9.e)
Predictors:				
Intercept	1.18 (0.08)	1.94 (0.14)	3.95 (0.19)	1.52 (0.12)
Level-1				
Room-type	0.38 (0.18)*	-0.01 (0.17)	-0.05 (0.10)	-0.23 (0.11)*
Interruptions	0.01 (0.12)	0.07 (0.02)**	-0.02 (0.02)	0.06 (0.02)**
Cross-level				
Conscientiousness	-0.16 (0.14)	0.27 (0.27)	0.88 (0.47)	0.21 (0.27)
Conscientiousness x Interruptions	-0.001 (0.03)	-0.06 (0.03)*	-0.003 (0.02)	-0.07 (0.04)

*p < 05, **p < .001

Table 14

Multilevel Moderated Mediation Random Coefficient Models: Psychological Resilience

	Task completion rate (H10.a)	Perceived stress (H10.c)	Positive affect (H10.d)	Negative affect (H10.e)
Predictors:				
Intercept	1.18 (0.08)	1.94 (0.14)	3.95 (0.20)	1.53 (0.13)
Level-1				
Room-type	0.37 (0.18)*	-0.02 (0.19)	-0.06 (0.09)	-0.23 (0.10)*
Interruptions	0.01 (0.01)	0.07 (0.02)**	-0.01 (0.02)	0.06 (0.02)*
Cross-level				
Psychological resilience	-0.09 (0.15)	-0.20 (0.33)	0.86 (0.48)	0.11 (0.28)
Psychological resilience x Interruptions	0.02 (0.02)	0.01 (0.03)	0.01 (0.03)	-0.01 (0.03)

*p < 05, **p < .001

in DO rooms compared to SO rooms (γ = 1.37, SE = 0.7, p = .050). A significant direct effect was also found between interruptions and task completion rate (γ = 0.37, SE=0.18, p = .045), indicating that task completion rate was higher in DO rooms compared to SO rooms. Interruptions did not have a significant effect on task completion rate (γ = 0.01, SE = 0.01, p = 0.65). Stress mindset, entered as a cross-level moderator, had a significant effect on task completion rate (γ =-0.11, SE = 0.05, p = 0.36); however, there was no significant effect of stress mindset in the cross-level interaction with interruptions (γ = 0.01, SE =0.01, p = 0.61). Given that there was no significant effect of stress mindset in the cross-level interaction with interruptions, no further probing of H8a via simple slopes test was conducted.

H8c. The multilevel moderated mediation random coefficient model for H8c, where interruptions are hypothesized to mediate the effect of room-type on perceived stress, and stress mindset is hypothesized to moderate that effect, was not supported. The path indicating room-

type as a predictor of interruptions was marginally significant, where interruptions increase in DO rooms compared to SO rooms ($\gamma = 1.37$, SE = 0.70, $p = .051$). The direct effect between room-type and perceived stress was nonsignificant ($\gamma = -0.02$, SE=0.19, $p = .92$). Interruptions had a significant effect on perceived stress ($\gamma = 0.07$, SE = 0.02, $p = 0.002$). Stress mindset, entered as a cross-level moderator, did not have a significant effect on perceived stress ($\gamma = -0.13$, SE = 0.13, $p = 0.32$); nor was there was a significant effect of stress mindset in the cross-level interaction with interruptions ($\gamma = 0.001$, SE =0.01, $p = 0.94$). Given that there was no significant effect of stress mindset in the cross-level interaction with interruptions, no further probing of H8c via simple slopes test was conducted.

H8d. The multilevel moderated mediation random coefficient model for H8d, where interruptions are hypothesized to mediate the effect of room-type on positive affect, and stress mindset is hypothesized to moderate that effect, was not supported. The path indicating room-type as a predictor of interruptions was marginally significant, where interruptions increase in DO rooms compared to SO rooms ($\gamma = 1.36$, SE = 0.70, $p = .052$). The direct effect between room-type and positive affect was nonsignificant ($\gamma = -0.06$, SE=0.09, $p = .51$). Interruptions had a nonsignificant effect on positive affect ($\gamma = -0.02$, SE = 0.02, $p = 0.35$). Stress mindset, entered as a cross-level moderator, did not have a significant effect on positive affect ($\gamma = 0.35$, SE = 0.25, $p = 0.15$); nor was there was a significant effect of stress mindset in the cross-level interaction with interruptions ($\gamma = 0.01$, SE =0.01, $p = 0.28$). Given that there was no significant effect of stress mindset in the cross-level interaction with interruptions, no further probing of H8d via simple slopes test was conducted.

H8e. The multilevel moderated mediation random coefficient model for H8e, where interruptions are hypothesized to mediate the effect of room-type on negative affect, and stress

mindset is hypothesized to moderate that effect, was not supported. The path indicating room-type as a predictor of interruptions was marginally significant, where interruptions increase in DO rooms compared to SO rooms ($\gamma = 1.37$, SE = 0.70, $p = .051$). The direct effect between room-type and negative affect was significant ($\gamma = -0.23$, SE=0.10, $p = .03$). This finding indicates that negative affect decreases when (or nurses felt less negative emotion) providing care in DO rooms compared to SO rooms. Interruptions had a significant effect on negative affect ($\gamma = 0.06$, SE = 0.02, $p = 0.01$), indicating that negative affect increase (or nurses feel more negative emotion) as interruptions increase. Stress mindset, entered as a cross-level moderator, did not have a significant effect on negative affect ($\gamma = 0.19$, SE = 0.12, $p = 0.10$); nor was there a significant effect of stress mindset in the cross-level interaction with interruptions ($\gamma = -0.01$, SE = 0.02, $p = 0.70$). Given that there was no significant effect of stress mindset in the cross-level interaction with interruptions, no further probing of H8e via simple slopes test was conducted.

H9a. The multilevel moderated mediation random coefficient model for H9a, where interruptions are hypothesized to mediate the effect of room-type on task completion rate, and conscientiousness is hypothesized to moderate that effect, was not supported. The path indicating room-type as a predictor of interruptions was marginally significant, where interruptions increase in DO rooms compared to SO rooms ($\gamma = 1.37$, SE = 0.70, $p = .050$). The direct effect between room-type and task completion rate was significant ($\gamma = 0.38$, SE=0.18, $p = 0.04$). This finding indicates that task completion rate increases when providing care in DO rooms compared to SO rooms. Interruptions had a nonsignificant effect on task completion rate ($\gamma = 0.01$, SE = 0.01, $p = 0.67$). Conscientiousness, entered as a cross-level moderator, did not have a significant effect on task completion rate ($\gamma = -0.16$, SE = 0.14, $p = 0.25$); nor was there a significant effect of conscientiousness in the cross-level interaction with interruptions ($\gamma = 0.001$,

SE = 0.03, p = 0.98). Given that there was no significant effect of conscientiousness in the cross-level interaction with interruptions, further probing of H9a via simple slopes test was not conducted.

H9c. The multilevel moderated mediation random coefficient model for H9c, where interruptions are hypothesized to mediate the effect of room-type on perceived stress, and conscientiousness is hypothesized to moderate that effect, was not supported. The path indicating room-type as a predictor of interruptions was marginally significant, where interruptions increase in DO rooms compared to SO rooms (γ = 1.37, SE = 0.70, p = .051). The direct effect between room-type and perceived stress was nonsignificant (γ = -0.01, SE=0.17, p = 0.97). Interruptions had a significant effect on perceived stress (γ = 0.07, SE = 0.02, p = 0.001). Conscientiousness, entered as a cross-level moderator, did not have a significant effect on perceived stress (γ = -0.27, SE = 0.27, p = 0.32); however, was there was a significant effect of conscientiousness in the cross-level interaction with interruptions (γ = - 0.06, SE = 0.03, p = 0.046). Given that there was a significant effect of conscientiousness in the cross-level interaction with interruptions, further probing of H9c via simple slopes test was conducted.

Following the procedure described in Chapter 4, the simple slopes tests yielded significant simple slopes at high (γ = .036, $p < .05$) and low (γ = .10, $p < .01$) levels of conscientiousness. This prompted the final probe of the MCMAM tests of the moderated mediation effect at high and low levels of conscientiousness. The MCMAM tests of both high levels (γ = 0.05, SE = 0.04, 95% CI [-0.0026, 0.1561]) and low levels (γ = 0.14, SE = 0.10, 95% CI [-0.0010, 0.3793]) of conscientiousness failed. Thus, H9c was not supported.

H9d. The multilevel moderated mediation random coefficient model for H9d, where interruptions are hypothesized to mediate the effect of room-type on positive affect, and

conscientiousness is hypothesized to moderate that effect, was not supported. The path indicating room-type as a predictor of interruptions was marginally significant, where interruptions increase in DO rooms compared to SO rooms (γ = 1.36, SE = 0.70, p = .052). The direct effect between room-type and positive affect was nonsignificant (γ = -0.05, SE = 0.10, p = 0.60). Interruptions did not have significant effect on positive affect (γ = -0.02, SE = 0.02, p = 0.37). Conscientiousness, entered as a cross-level moderator, did not have a significant effect on positive affect (γ = 0.88, SE = 0.47, p = 0.06); nor was there was a significant effect of conscientiousness in the cross-level interaction with interruptions (γ = - 0.003, SE = 0.02, p = 0.85). Given that there was no significant effect of conscientiousness in the cross-level interaction with interruptions, no further probing of H9d via simple slopes test was conducted.

H9e. The multilevel moderated mediation random coefficient model for H9e, where interruptions are hypothesized to mediate the effect of room-type on negative affect, and conscientiousness is hypothesized to moderate that effect, was not supported. The path indicating room-type as a predictor of interruptions was marginally significant, where interruptions increase in DO rooms compared to SO rooms (γ = 1.36, SE = 0.70, p = .051). The direct effect between room-type and negative affect was also significant (γ = -0.23, SE = 0.11, p = 0.03), indicating that negative affect decreases (or nurses felt less negative emotion) when providing care in DO rooms compared to SO rooms. Interruptions also had a significant effect on negative affect (γ = 0.06, SE = 0.02, p = 0.37), indicating that negative affect increases (or nurses felt more negative emotion) as interruptions increase. Conscientiousness, entered as a cross-level moderator, did not have a significant effect on negative affect (γ = -0.21, SE = 0.27, p = 0.43); nor was there was a significant effect of conscientiousness in the cross-level interaction with interruptions (γ = - 0.06, SE = 0.04, p = 0.11). Given that there was no significant effect of

conscientiousness in the cross-level interaction with interruptions, no further probing of H9e via simple slopes test was conducted.

H10a. The multilevel moderated mediation random coefficient model for H10a, where interruptions are hypothesized to mediate the effect of room-type on task completion rate, and psychological resilience is hypothesized to moderate that effect, was not supported. The path indicating room-type as a predictor of interruptions was marginally significant, where interruptions increase in DO rooms compared to SO rooms ($\gamma = 1.37$, SE = 0.70, $p = .050$). The direct effect between room-type and task completion rate was also significant ($\gamma = 0.37$, SE =0.18, $p = 0.046$), indicating that task completion rate increases when providing care in DO rooms compared to SO rooms. Interruptions had a nonsignificant effect on task completion rate ($\gamma = 0.01$, SE = 0.01, $p = 0.61$). Psychological resilience, entered as a cross-level moderator, did not have a significant effect on task completion rate ($\gamma = -0.09$, SE = 0.15, $p = 0.57$); nor was there was a significant effect of psychological resilience in the cross-level interaction with interruptions ($\gamma = 0.02$, SE = 0.02, $p = 0.47$). Given that there was no significant effect of psychological resilience in the cross-level interaction with interruptions, no further probing of H10a via simple slopes test was conducted.

H10c. The multilevel moderated mediation random coefficient model for H10c, where interruptions are hypothesized to mediate the effect of room-type on perceived stress, and psychological resilience is hypothesized to moderate that effect, was not supported. The path indicating room-type as a predictor of interruptions was marginally significant, where interruptions increase in DO rooms compared to SO rooms ($\gamma = 1.37$, SE = 0.70, $p = .051$). The direct effect between room-type and perceived stress was nonsignificant ($\gamma = -0.02$, SE =0.19, $p = 0.92$). Interruptions had a significant effect on perceived stress ($\gamma = 0.07$, SE = 0.02, $p =$

0.003), indicating that perceived stress increase as interruptions increase. Psychological resilience, entered as a cross-level moderator, did not have a significant effect on perceived stress (γ = -0.20, SE = 0.33, p = 0.55); nor was there was a significant effect of psychological resilience in the cross-level interaction with interruptions (γ = 0.01, SE = 0.03, p = 0.86). Given that there was no significant effect of psychological resilience in the cross-level interaction with interruptions, no further probing of H10c via simple slopes test was conducted.

H10d. The multilevel moderated mediation random coefficient model for H10d, where interruptions are hypothesized to mediate the effect of room-type on positive affect, and psychological resilience is hypothesized to moderate that effect, was not supported. The path indicating room-type as a predictor of interruptions was marginally significant, where interruptions increase in DO rooms compared to SO rooms (γ = 1.36, SE = 0.70, p = .052). The direct effect between room-type and positive affect was nonsignificant (γ = -0.06, SE =0.09, p = 0.52). Interruptions had a nonsignificant effect on positive affect (γ = -0.01, SE = 0.02, p = 0.41). Psychological resilience, entered as a cross-level moderator, did not have a significant effect on positive affect (γ = 0.86, SE = 0.48, p = 0.07); nor was there was a significant effect of psychological resilience in the cross-level interaction with interruptions (γ = 0.01, SE = 0.03, p = 0.62). Given that there was no significant effect of psychological resilience in the cross-level interaction with interruptions, no further probing of H10d via simple slopes test was conducted.

H10e. The multilevel moderated mediation random coefficient model for H10e, where interruptions are hypothesized to mediate the effect of room-type on negative affect, and psychological resilience is hypothesized to moderate that effect, was not supported. The path indicating room-type as a predictor of interruptions was marginally significant, where interruptions increase in DO rooms compared to SO rooms (γ = 1.36, SE = 0.70, p = .051). The

direct effect between room-type and negative affect was significant (γ = -0.23, SE =0.10, p = 0.02), indicating that negative affect decreases (or nurses felt less negative emotion) when providing care in DO rooms compared to SO rooms. Interruptions also had a significant effect on negative affect (γ = 0.06, SE = 0.02, p = 0.01). Psychological resilience, entered as a cross-level moderator, did not have a significant effect on negative affect (γ = 0.11, SE = 0.28, p = 0.69); nor was there was a significant effect of psychological resilience in the cross-level interaction with interruptions (γ = -0.01, SE = 0.03, p = 0.69). Given that there was no significant effect of psychological resilience in the cross-level interaction with interruptions, no further probing of H10e via simple slopes test was conducted.

Summary

The findings in this chapter construct a nuanced picture of room types, interruptions, and their consequences. Table 15 presents a summary of findings in this chapter. A summary of the significant findings follows.

First, room-type is a consistent significant predictor of interruptions in all but one (H5) of the four mediation models and all but one (H8d) of the 12 multilevel moderated mediation models. This validates the findings of the Mann-Whitney U test of statistical differences of interruptions by room-type.

Second, interruptions did mediate the effects of room-type on perceived stress. This finding was supported in testing Hypothesis 4 and documented in Table 11. In other words, the effect of room-type on perceived stress is transmitted through the frequency of interruptions.

Third, although H9c failed the MCMAM test and was not fully supported, in this model conscientiousness acts as a significant cross-level moderator in the multilevel moderated mediation model. This finding was documented in Figure 11 and Table 12. It indicates that the

Table 15

Summary of Hypotheses and Findings

Hypotheses	Finding
H_1: Nurses providing care in DO rooms will experience more interruptions than when providing care in SO rooms.	Fully supported
H_2: Interruptions mediate the effect of room-type on task completion rate, where increased frequency of interruptions decreases task completion rate.	Partially supported
H_3: Interruptions mediate the effect of room-type on MAEs, where increased frequency of interruptions increases rate of MAEs.	Unable to test
H_4: Interruptions mediate the effect of room-type on perceived stress, where increased frequency of interruptions increases perceived stress.	Fully supported
H_5: Interruptions mediate the effect of room-type on positive affect, where increased frequency of interruptions decreases experience of positive affect.	Partially supported
H_6: Interruptions mediate the effect of room-type on negative affect, where increased frequency of interruptions increases experience of negative affect.	Partially supported
H_7: The mediating effect of interruptions on task completion rate, MAEs, perceived stress, positive affect, and negative affect occurring during a patient episode will contribute to (a) task completion rate, (b) MAEs, (c) perceived stress, (d) positive affect, and (e) negative affect in subsequent care episodes.	Unable to test
H_{8a}: The mediated relationship between room-type and task completion rate is weaker for those nurses who view stress as enhancing compared to those who view stress as debilitating.	Not supported
H_{8b}: The mediated relationship between room-type and MAEs is weaker for those nurses who view stress as enhancing compared to those who view stress as debilitating.	Unable to test

Table 15 - continued

Hypotheses	Findings
H_{8c}: The mediated relationship between room-type and perceived stress is weaker for those nurses who view stress as enhancing compared to those who view stress as debilitating.	Not supported
H_{8d}: The mediated relationship between room-type and positive affect is weaker for those nurses who view stress as enhancing compared to those who view stress as debilitating.	Not supported
H_{8e}: The mediated relationship between room-type and negative affect is weaker for those nurses who view stress as enhancing compared to those who view stress as debilitating.	Not supported
H_{9a}: The mediated relationship between room-type and task completion rate is weaker for those high in conscientiousness compared to those low in conscientiousness.	Not supported
H_{9b}: The mediated relationship between room-type and MAEs is weaker for those high in conscientiousness compared to those low in conscientiousness.	Unable to test
H_{9c}: The mediated relationship between room-type and perceived stress is weaker for those high in conscientiousness compared to those low in conscientiousness.	Not supported
H_{9d}: The mediated relationship between room-type and positive affect is weaker for those high in conscientiousness compared to those low in conscientiousness.	Not supported
H_{9e}: The mediated relationship between room-type and negative affect is weaker for those high in conscientiousness compared to those low in conscientiousness.	Not supported
H_{10a}: The mediated relationship between room-type and task completion rate is weaker for those high in psychological resilience compared to those low in psychological resilience.	Not supported
H_{10b}: The mediated relationship between room-type and MAEs is weaker for those high in psychological resilience compared to those low in psychological resilience.	Unable to test

Table 15 - continued

Hypotheses	Findings
H_{10c}: The mediated relationship between room-type and perceived stress is weaker for those high in psychological resilience compared to those in low psychological resilience.	Not supported
H_{10d}: The mediated relationship between room-type and positive affect is weaker for those high in psychological resilience compared to those low in psychological resilience.	Not supported
H_{10e}: The mediated relationship between room-type and negative affect is weaker for those high in psychological resilience compared to those low in psychological resilience.	Not supported

intrapersonal resource of conscientiousness potentially has the potential to moderate or buffer the effects of interruptions.

Finally room-type had some surprising direct effects. In H2, H8a, H9a, and H10a, room-type had a significant positive direct effect on task completion rate. This indicates that task completion rate increases in DO rooms compared to SO rooms. This was the opposite of the hypothesized direction of task completion rate. This direct effect occurred even in the absence of a significant relationship between interruptions and task completion rate in the same model. Similarly, room-type also had a significant negative direct effect on negative affect in the testing of H8e and H9e. This finding is also the opposite of the hypothesized direction and indicates that negative affect decreases when (or nurses felt less negative emotion) when providing care in DO rooms compared to SO rooms. Further research is needed to understand the effect of room-type on task completion and negative affect.

Chapter 6

Introduction

This research set out to better understand predictors and consequences of inpatient care interruptions through three specific aims organized into four research questions with accompanying hypotheses. Research Aim 1 sought to determine if the built health care environment systematically contributes to interruption frequency, asking Research Question 1: Does frequency of interruptions differ by patient room type? To answer this question, I employed JD-R theory to hypothesize that (H1) nurses providing care in DO rooms will experience more interruptions than when providing care in SO rooms.

Research Aim 2 sought to understand how interruptions contribute to nurse performance and well-being, by asking the following two research questions: (a) do interruptions mediate the relationship between room-type and task completion, medication administration errors, perceived stress, and experience of positive affect and negative affect; and (b) do interruptions occurring early in a nurse's shift continue to have negative consequences later in the shift? To answer these questions, I supplemented JD-R theory with theories of cognitive interference, affective events theory, and the episodic model of performance to offer hypotheses H2, H4, H5, and H6.

Finally, Research Aim 3 sought to examine whether individual nurse characteristics might buffer against the negative effects of interruptions, and asking Research Question 4, do certain intrapersonal resources of nurses mitigate the negative effects of interruptions? As described in Chapter 3, I employed the interaction effect of JD-R theory to posit a buffering

effect of intrapersonal resources that mitigate the effect of interruptions in the work environment to frame the following hypotheses H8, H9, and H10.

This chapter is divided into three sections. Section I offers a discussion of the overall contribution of this study. Section II discusses the findings of the hypotheses tested, with practice applications and implication for future research discussed where applicable. Finally, Section III discusses the limitations of this study. It is organized according to limitations to external and internal validity and concludes this chapter.

Section I: Contribution of Study

As described in this study, interruptions create a complex challenge in health care. Interruptions in the health care setting continue to gain recognition that pose a threat to the delivery of safe, effective, and efficient care (Tucker & Spear, 2006). They have been found to be systemic and pervasive in the hospital environment with a host of deleterious effects (Grundgeiger & Sanderson, 2009; Rivera-Rodriguez & Karsh, 2010; Tucker & Spear, 2006; Westbrook, Coiera et al., 2010; Westbrook, Woods et al., 2010). Yet, there remains of dearth of evidence that describes predictors of interruptions, how these interruptions take their effect on individual care providers, and what factors may mitigate that effect.

This study fills these gaps by showing room-type to be a predictor of interruptions. This study also fills a gap in the literature by considering interruptions from a perspective of JD-R that conceptualizes organizational and human characteristics as interacting with internal human characteristics (i.e., intrapersonal resources) to affect different performance and well-being outcomes (Bakker et al., 2003; Bakker et al., 2005). I did this by developing a single conceptual model that considers both contributing and mitigating factors of interruptions. Moreover, I

utilized a body of theoretical support for my conceptual model, which fills another critical gap in existing atheoretical interruption research in the literature.

The study identifies room-type and physical environmental design as one predictor of antecedents. This finding contributes the body of evidence-based design literature related to the built healthcare environment. It may be helpful in identifying potential physical design improvements that may increase patient safety. Over the last decade, evidence-based design has asserted that investments in certain evidence-based design elements, such as SO rooms, have the potential to yield improved patient safety and quality care outcomes (Stichler, 2008; Ulrich et al., 2004; Ulrich et al., 2008). Specifically, this study supports the continued transition in the United States from DO room designs, to SO room designs by showing that room-type is a predictor of interruptions and that interruptions have a positive indirect effect on perceived stress. These implications may be helpful in other countries as well.

By identifying that interruptions transmit the effect of room-type on perceived stress, with perceived stress increasing as interruptions increase, helps explain the preference of nurses for DO rooms (compared to SO rooms) that was discovered during ethnographic reconnaissance (see Chapter 4) prior to this study. Nurses clearly articulated a preference for providing care in SO rooms as compared to DO rooms. Understanding the indirect effect helps explain this preference. While a small sample size may have prevented this study from fully meeting its research aims, the above two findings contribute to a growing body of literature on evidence-based design and support the JD-R theory.

Section II: Findings, Implications, and Future Research

Expected and actual results stemming from these hypotheses are displayed in Table 16.

Table 16

Hypothesized Compared to Actual Findings

		Hypothesized		Actual	
	Dependent variable	Relationship	Direction	Relationship	Direction
Aim 1 (Research Question 1): H1: Nurses providing care in DO rooms will experience **more interruptions** than when providing care in SO rooms.	Room-type	Significant association	Interruptions DO > Interruptions SO	Significant association	Interruptions DO > Interruptions SO
Aim 2 (Research Question 2): H2: **Interruptions mediate the effect of room-type** on task completion rate, where increased frequency of interruptions decreases task completion rate.	Task completion rate	Mediation effect	-	Partially supported, direct effect only	+
H3: **Interruptions mediate the effect of room-type** on MAEs, where increased frequency of interruptions increases perceived stress.	MAEs	Mediation effect	+	Unable to test due to lack of statistical power	
H4: **Interruptions mediate the effect of room-type** perceived stress, where increased frequency of interruptions increases perceived stress.	Perceived stress	Mediation effect	+	Fully supported	+
H5: **Interruptions mediate the effect of room-type** on positive affect, where increased frequency of interruptions decreases experience of positive effect.	Positive affect	Mediation effect	-	Partially supported, direct effect only	+
H6: **Interruptions mediate the effect of room-type** on negative affect, where increased frequency of interruptions increases experience of negative affect.	Negative affect	Mediation effect	+	Partially supported, room-type predicts interruptions	N/A

Table 16 - continued

		Hypothesized		Actual	
	Dependent variable	Relationship	Direction	Relationship	Direction
Aim 2 (Research Question 3):					
H7: The mediating effect of interruptions on task completion rate, MAEs, perceived stress, positive affect, and negative affect occurring during a patient episode will contribute to (a) task completion rate, (b) MAEs, (c) perceived stress, (d) positive affect, and (e) negative affect in **subsequent care episodes.**	Dependent variable at times t2, t3, . . . and t6.	Significant association	+	Unable to test due to lack of statistical power	
Aim 3 (Research Question 4):					
H8: The mediated relationship between room-type and (a) task completion rate, (b) MAEs, (c) perceived stress, (d) positive affect, and (e) negative affect is weaker for those nurses who view **stress as enhancing compared to those who view stress as debilitating.**	(a) Task completion rate (b) MAEs (c) Perceived stress (d) Positive affect (e) Negative affect	Moderated mediation	(a) - (b) + (c) + (d) - (e) +	(a) Not supported (b) Unable to test (c) Not supported (d) Not supported (e) Not supported	N/A
H9: The mediated relationship between room-type and (a) task completion rate, (b) MAEs, (c) perceived stress (d) positive affect, and (e) negative affect is weaker for those **high in conscientiousness compared to those low in conscientiousness.**	(a) Task completion rate (b) MAEs (c) Perceived stress (d) Positive affect (e) Negative affect	Moderated mediation	(a) - (b) + (c) + (d) - (e) +	(a) Not supported (b) Unable to test (c) Not supported (d) Not supported (e) Not supported	N/A
H10: The mediated relationship between room-type and (a) task completion rate, MAEs, (c) perceived stress, (d) positive affect, and (e) negative affect is weaker for those **high in psychological resilience compared to those low in psychological resilience.**	(a) Task completion rate (b) MAEs (c) Perceived stress (d) Positive affect (e) Negative affect	Moderated mediation	(a) - (b) + (c)+ (d) - (e) +	(a) Not supported (b) Unable to test (c) Not supported (d) Not supported (e) Not supported	N/A

H1. The present study found that physical configuration of patient rooms is associated with greater interruptions. As hypothesized, interruptions occurred more frequently in DO inpatient rooms than in SO patient rooms. This is likely due to the fact that not only are multiple patients in these DO room simultaneously, but also the patients' visitors, care providers, and the equipment necessary to accommodate them. The presence of additional people and equipment in the room increases the potential sources of interruptions relative to SO rooms. This finding supports the assertion of Jett and George (2003) that the physical configuration of work spaces may bring people close together and increase the likelihood of unplanned encounters that interrupt a person's work.

H2-H6. In terms of the potential deleterious effects of interruptions, I hypothesized that frequency of interruptions acts as a specific job demand that creates excessive psychological demands on nurses and correspondingly impairs individual performance (task rate and MAEs) and well-being (perceived stress and changes in emotional states). Specifically, I hypothesized that interruptions mediate the effect of room-type, resulting in (H2) decreased task completion rate; (H3) increased MAEs; (H4) increased perceived stress; (H5) decreased experience of positive affect; and (H6) increased experience of negative affect.

Of H2-H6, only H4 was fully supported, indicating that interruptions mediate the effect of room-type, resulting in increased perceived stress. This finding (a) generally supports the affective events theory by linking the experience of a discrete work experience (i.e., interruptions) with emotional reactions (Weiss & Cropanzano, 1996); and (b) specifically supports the assertion of Jett and George (2003) that nurses perceive heightened levels of stress when faced with increasing interruptions.

In terms of H2, I found a marginally significant direct effect between interruptions and task completion rate. Room-type continued to marginally predict interruptions, but interruptions were not associated with task completion rate. Moreover, in testing H8a H9a, and H10a, task completion rate was higher in DO rooms compared to SO rooms. The number of tasks that a nurse *planned* to complete operated as the denominator in this measure, with the number of tasks a nurse *actually* completed acting as the numerator. In many instances, a nurse completed far more tasks than those that were planned, resulting in task completion rates of greater than 100%. According to H2's results, this phenomenon could be occurring more frequently in DO rooms than SO rooms.

One explanation for this could be because of the way task completion rate was defined in this study. A more refined definition of task completion rate that differentiates planned vs. unplanned tasks may better show the mediation effect of interruptions in this relationship. Otherwise, some additional unstudied factor is at play in creating additional actual tasks or activities for the nurse to complete. Additional research is needed to better understand this effect.

A more interesting explanation, however, may emerge when the results of H2, H8a, H9a, and H10a are combined with the results of H8e and H9e. The analyses associated with H8e and H9e indicate that DO rooms are associated with lower levels of negative affect when compared to SO rooms. This is also the opposite direction of what was hypothesized. This result was most surprising given that in interviews conducted as ethnographic reconnaissance (see Chapter 4) prior to this study nurses clearly articulated a dislike of providing care in DO rooms compared to SO rooms.

When considering that DO rooms result in higher task rate completion and lower levels of negative affect, I speculate that in the double rooms nurses may feel more satisfied in their task accomplishments, thus lowering their feelings of negative emotion. For this reason, I recommend that future research build on the work of Gabriel et al. (2011) to incorporate a dependent variable of satisfaction with task accomplishment when studying the effects of room-type on nurse affect.

H5 was not supported. This, too, presents a surprising result. Given the stated dislike of DO rooms in interviews with nurses on this unit, one would expect to see a diminished positive a experience in the setting. Future research may consider other mediators or other measures of emotional response that better capture the effect of this room-type. For example, emotional labor may be a factor an element of work that nurses must take on in DO rooms that is not considered in this study.

H7-H10. In presenting H7-H10, I argued that three intrapersonal resources may buffer the effects of interruptions by allowing nurses to be prepared for (i.e., positive stress mindset), manage (i.e., conscientiousness), and overcome (i.e., psychological resilience) interruptions and their accompanying off-task attentional demands (Steel, 2007). These hypotheses operationalized the interactive conceptualization of JD-R theory which asserts that employee performance and well-being can be maintained even when it is difficult to reduce or redesign job demands (Bakker & Demerouti, 2007; Bakker et al., 2005). This maintenance of performance and well-being is crucial in the health care setting when the levels of job demands can be high and unpredictable.

Unfortunately, in testing each of these hypotheses via multilevel moderated mediation models, none of the hypotheses were fully supported. However, some partial effects were found.

Conscientiousness had a significant moderating effect on perceived stress (see Chapter 5, Figure H9c). These partial effects support the notion that certain intrapersonal resources may buffer the deleterious effects of job demands. There may be components of conscientiousness (e.g., a tendency to always be prepared) that lessen heightened perceptions of stress related to feeling as if difficulties are piling up.

Despite the limited support for H7-H10, future research is a worthy endeavor for further exploring the interactive perspective of JD-R wherein organizational characteristics of the workplace (i.e., room-type and interruptions) are conceptualized as interacting with internal human characteristics (i.e., intrapersonal resources) to affect different performance and well-being outcomes (Bakker, Demerouti et al., 2005; Bakker et al., 2003). This study has shown that conscientiousness can buffer against the effects of interruptions. Further determining which intrapersonal resources may act as the best buffers against particular job demands is a helpful approach to job recruitment and training. Personality screenings and other means of assessing a nurse's intrapersonal resources can help nurses determine which settings and job demands and/or resources best supplement or match a nurse's intrapersonal resources.

An additional promising application of this line of inquiry can apply recent research which shows that some intrapersonal resources may be developed or built in employees who may lack them; the mostly likely of the posited resources being positive stress mindset. Crum and colleagues (2013) found that stress mindset could be altered with simple and affordable priming interventions, resulting in improved performance and psychological symptoms of stress. Thus, interventions can be implemented to bolster the intrapersonal resources nurses may be lacking to buffer job demands.

Section III: Limitations

As with any research, this study has several potential and actual limitations. Potential limitations are those limitations that pose a risk to this study but were not known to have actually occurred. Actual limitations are those that were documented to have occurred. This section outlines those limitations according to threats to external and internal validity.

External Validity

First and foremost was the issue of sample size. Although there was general support for this study on the hospital unit observed, only 20 total nurses consented to participate. This lower than anticipated sample size resulted in insufficient statistical power to test the more complex relationships as planned in my methodology. As most statistical tests require a large sample size to ensure a representative distribution of the population, finding significant relationships from the data proved difficult. Moreover, this small sample size precludes the consideration of the nurse sample as representative of others to generalized results. This threat to external validity of this study is a major limitation. To guard against this in the future, I would recommend securing appropriate incentives for nurses to participate in the study.

A second threat to external validity, that also contributed to the small sample size, was time constraint. On average, a nurse observation of six care episodes lasted approximately 4 hours. This observation length was longer than anticipated. Having conducted over 80 hours of nurse observations, time constraints limited the ability to observe more than 20 nurses. This contributed to the challenges with sample size described in the preceding paragraph. Future research must consider the time it takes to observe repeated measures that occur throughout a nurse's shift.

A third threat to external validity was the fact that this study was conducted on a single progressive-care unit in a large, tertiary academic health system on the east coast. Similar findings may not apply to nurses working on other hospital units or in other hospitals/health systems.

Internal Validity

The remaining limitations in this section describe potential threats to internal validity of this study. The first threat to internal validity results from the observatory nature of this study and the Hawthorne effect. According to the Hawthorne effect, individuals will perform better than usual when they know their performance is being monitored through observations. This limitation is to be expected in any observational study. The nurses observed in this study work in an academic health system and are observed on a daily basis by their patients, patient visitors, other team members, and by other health professional students who routinely "shadow" nurses in their health professional training and education. Although these nurses are certainly not immune to the Hawthorne effect, the nurses did not necessarily experience their work being observed by the researcher to have any more effect than their typical daily experience.

A second threat to internal validity in this study is the self-reported data obtained through the nurse questionnaires and episodic surveys. Self-reported data is a limitation in that it cannot be independently verified and can contain several potential sources of bias that you should be alert to and note as limitations. While no biases were suspected by the researcher, some specific biases in the nurses' self-reported data that may be at play due to the very nature of self-reporting are: (a) selective memory (remembering or not remembering experiences or events that occurred at some point in the past); and (b) social desirability (the act of answering questions about normative behavior in a way that will appear prosocial to interviewers) (Brenner & DeLamater,

2016). It is important to note, however, that these data related to internal emotion states would be difficult to obtain in a manner other than self-report.

Related is a third threat to internal validity study—the data was solely observed by the researcher. There were no other researchers to observe and validate the data collected through observation. Inaccurate transcription of data is a potential risk. However, every opportunity was maximized in observation protocols to ensure that the recorded data was accurate. Protocols were created in such a way that observation data could be easily tracked and recorded. My personal background of acute care nursing also helped me easily understand and adapt to the environment in which I was observing nurses.

Because of the limitations described above, this study should be considered an exploratory study that provides important initial insights on the relationship between room-type, interruptions, and important nursing outcomes. Moreover, it provides a foundation for future research to test all the proposed hypotheses with a higher sample size.

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Appendices

Appendix A—Interruptions Literature

Table A-1.

*Characteristics of reviewed studies**

Author(s)	*Year*	*Study aim*	*Design*	*Data collection*	*Statistical analysis*
Alvarez & Coiera	2005	Examine communication interruptions within an intensive care unit (ICU) during ward rounds.	Non-experimental	Observation, audio recording	Descriptive statistics
Anthony et al.	2010	Evaluate the effect of a "no interruption" zone on interruptions during medication preparation in the ICU.	Quasi-experimental	Observation	Descriptive statistics
Ballerman et al.	2011	Evaluate a previously described method of quantifying amounts of time spent and interruptions encountered by health care providers working in two ICUs.	Non-experimental	Observation	Comparative statistics
Bennet et al.	2006	Compare a traditional unit medication cart system with a system using a locked medical n cupboard in each patient's room.	Mixed, non-experimental and qualitative	Self-tracking, focus groups	Descriptive statistics
Biron et al.	2009	Document characteristics of nurses' work interruptions during medication administration.	Non-experimental	Observation	Descriptive statistics
Brixey et al.	2007	The categorization of activities and interruptions recorded during an ethnographic study of physicians and registered nurses in a Level One Trauma Center.	Mixed, non-experimental and qualitative	Observation, interviews	Descriptive statistics

Table A-2 Continued

Author	*Year*	*Study aim*	*Design*	*Data collection*	*Statistical analysis*
Brixey et al.	2008	Conduct a case study using an ethnographic research design observe, record, and contextualize activities and interruptions experienced by physicians and rns working in a Level One Trauma Center.	Mixed, non-experimental and qualitative	Observation	Descriptive statistics, qualitative data analysis
Chisholm et al.	2000	Determine the number and types of interruptions in the ED.	Non-experimental	Observation, time-motion	Comparative statistics
Chisholm et al.	2001	Determine the number of interruptions and to characterize tasks performed in emergency departments compared with those performed in primary care offices.	Non-experimental	Observation	Descriptive statistics
Coiera & Tombs	1998	Identify patterns of communication behavior among hospital-based health care workers.	Mixed, non-experimental and qualitative	Observation, audio recording	Descriptive statistics
Coiera et al.	2002	Measure communication loads on clinical staff in an acute clinical setting, and to describe the pattern of informal and formal communication events.	Non-experimental	ObservationAudio recording	Descriptive statistics
Collins et al.	2007	Describes the use of a taxonomy to characterize and analyze distractions and subsequent actions in the setting of computer physician order entry and information system usage.	Non-experimental	Observation	Descriptive statistics
Dearden et al.	1996	Pilot study to measure the frequency and sources of interrupted consultations and to examine the patient's view of the effect of the interruption on the consultation.	Mixed, quasi-experimental and qualitative	Observations, surveys	Descriptive statistics, qualitative data analysis

Table A-3 Continued

Author	*Year*	*Study aim*	*Design*	*Data collection*	*Statistical analysis*
Ebright et al.	2003	Increase understanding of RN work complexity in an acute care setting using a human performance framework.	Mixed, non-experimental and qualitative	Observations, interviews	Descriptive statistics
Edwards et al.	2009	Gain a better understanding of inter-clinician communication behaviors, routine workflow patterns, and the use of information communication technologies (icts) within the clinical workspace.	Non-experimental	Observations	Descriptive statistics
Elfering et al	2011	Determine the association between nursing job characteristics (stressors and resources-job control) that are likely to disturb cognitive function, i.e. Elicit cognitive failures while working.	Non-experimental	Questionnaire	Inferential: step-wise linear multiple regression
Elganzouri et al	2009	Develop and test a method for assessing nursing effort and workflow in the medication administration process.	Non-experimental	Observation	Descriptive statistics
Fairbanks et al.	2007	Characterize and describe the communication links and patterns between and within emergency department providers.	Non-experimental	Observation, audio recording	Descriptive statistics
Flynn et al.	1999	Determine whether dispensing errors are influenced by interruptions or distractions.	Non-experimental	Observation, visual acuity, hearing, Distractibility tests, video	Comparative statistics
France et al.	2005	Study and describe provider work and communication processes in an ED equipped with a distributed electronic whiteboard.	Non-experimental	Observation, Time-motion	Comparative statistics

Table A-4 Continued

Author	*Year*	*Study aim*	*Design*	*Data collection*	*Statistical analysis*
Freeman et al	2013	Describe a bundle of safety interventions to reduce interruptions during medication administration and medication errors.	Quasi-experimental	Observation	Descriptive statistics
Friedman et al.	2005	Time and motion analysis of emergency physician to characterize emergency physician (EP) time utilization and patterns of interruption and identify correlates of interruptions.	Non-experimental	Observation	Descriptive statistics
Fry & Dacey	2007	Establish the views of nurses on the importance of a list of factors potentially contributing to medication incidents and to explore their professional and personal views of the consequences of reporting such incidents.	Non-experimental	Questionnaire	Comparative statistics
Grundgeiger et al.	2010	Use the memory for goals theory and prospective memory theory to investigate which properties of an interruption influence how long it takes nurses to resume interrupted critical care tasks--investigate factors that might make it easier or harder for people to return to an interrupted task.	Non-experimental	Eye-tracker, video, interviews	Inferential: multiple regression
Harvey et al.	1994	Assess the patterns of paging medical interns during night calls.	Non-experimental	Daily diary	Comparative statistics
Healey et al.	2006	Observational tool was developed to record distraction and interruption in the operating theatre during surgery.	Non-experimental	Observation	Comparative statistics

Table A-5 Continued

Author	*Year*	*Study aim*	*Design*	*Data collection*	*Statistical analysis*
Healey et al.	2007	Quantify distraction and interruption to the sterile surgical team in urology.	Non-experimental	Observation	
Hedberg & Larsson	2004	Explore environmental elements related to decision-making process in nursing practice.	Qualitative	Unstructured observation	
Hillel & Vicente	2003	Observe, quantify, and classify interruptions in nursing care.	Non-experimental	Observation	
Hillsden & Fenton	2006	Identify areas of practice that could be improved to reduce medication errors.	Non-experimental	Observation, chart review	Descriptive statistics
Kalisch & Aebersold	2010	Extent and type of interruptions and multitasking of nurses, as well as patient errors.	Non-experimental	Observation	Descriptive statistics
Kliger et al	2009	Show the effect of improvements in the work environment on the accuracy of medication administration as measured by direct observation.	Quasi-experimental	Observation	Descriptive statistics
Kosits & Jones	2011	Determine (a) the frequency, (b) the type, and (c) the percentage of interruptions that take place during medication related activities for ED nurse	Non-experimental	Observation	Descriptive statistics
Kreckler et al.	2008	Quantitative observational study of the frequency, type and duration of interruptions during drug to determine the scale of the problem, and to identify sources of interruption that might be addressed.	Non-experimental	Observation	Descriptive statistics

Table A-6 Continued

Author	*Year*	*Study aim*	*Design*	*Data collection*	*Statistical analysis*
Laxmisan et al.	2007	Reports on the nature of multitasking and shift change and its implications for patient safety in an adult ED.	Non-experimental	Observation	Descriptive statistics
Liu & Grundgeiger et al.	2009	Analysis of whether an interruption affects whether anesthesiologists will detect an omitted bedside pre-transfusion check.	Non-experimental	Simulator-based study augmented with a head-mounted display; video coding (from headset)	Comparative statistics
Luketich et al.	2002	Assess the impact of voice recognition technology used during surgical procedure on operating room efficiency and user satisfaction	Quasi-experimental	Oobservation	Descriptive statistics
Lyons Brown et al.	2007	Objectively evaluate the organization of triage and issues that may affect the effectiveness of the process.	Non-experimental	Observation	Descriptive statistics
Manias et al.	2002	Investigate the effectiveness of observations for exploring nurse-patient interactions for pain assessment and management in hospitalized postsurgical patients and to identify barriers that surround nursing pain management decisions.	Qualitative	Observation,Audio,Interviews	Descriptive statistics,Qualitative data analysis
McGillis Hall, Ferguson-Pare et al.	2010	Examine interruptions to nurses' work, the systems issues related to these and the associated outcomes.	Mixed, non-experimental and qualitative	Observation, focus group	Comparative statistics, qualitative data analysis
McGillis Hall, Pedersen, & Fairley	2010	Examine the processes and factors that are connected with interruptions, including the sources, types, causes, nursing activity interrupted, and the outcomes of these.	Mixed, non-experimental and qualitative	Observation, focus group	Comparative statistics, qualitative data analysis

Table A-7 Continued

Author	*Year*	*Study aim*	*Design*	*Data collection*	*Statistical analysis*
McGillis Hall, Pedersen, Hubley et al.	2010	Explore interruptions in pediatric nurses' work and the systems issues related to interruptions in nursing work environments.	Mixed, non-experimental and qualitative	Observation, focus group	Comparative statistics, qualitative data analysis
Palese et al.	2009	Examine the frequency and perceived risk of interruptions to nurses during drug rounds.	Mixed, non-experimental and qualitative	Observation, interview	Descriptive statistics
Pape	2003	Measure the effect of two targeted interventions (Medsafe vest vs. Checklist alone) based on airline industry measure for decreasing nurse's distraction during medication administration.	Quasi-experimental	Observation	Comparative statistics
Pape et al.	2005	Intervention to reduce nurse distraction during medication rounds.	Quasi-experimental	Self-report	Comparative statistics
Popescu et al.	2011	Explore the multifactorial influences on medication quality and safety in the context of a single checking policy for medication administration in acute care.	Mixed, non-experimental and qualitative	Observation, interview	Descriptive statistics
Potter et al.	2005	Analyze the nature of nurses' cognitive work and how environmental factors create disruptions that pose risks for medical errors.	Mixed, non-experimental and qualitative	Observation, interview	Descriptive statistics
Potter et al.	2004	New methodology for mapping the nursing process, described as a cognitive pathway, was developed.	Non-experimental	Observation	Descriptive statistics
Redding & Robinson	2009	Describe type and frequency of work interruptions for nurses to identify methods of reducing interruptions.	Non-experimental	Observation	Descriptive statistics

Table A-8 Continued

Author	*Year*	*Study aim*	*Design*	*Data collection*	*Statistical analysis*
Relihan et al.	2010	Assess the impact of a set of interventions in reducing the interruption/distraction rate during medication administration.	Quasi-experimental	Observation	Inferential: poisson regression analysis
Rhoades et al.	2001	Examine physician-patient communication patterns, and interruptions in communication, during patient visits with family practice and internal medicine residents.	Non-experimental	Observation	Comparative statistics
Scott-Cawiezell et al.	2007	Determine the impact of various levels of credentialing among nursing home staff who deliver medications (RN, LPN, or CMT/A) on medication error.	Non-experimental	Observation	Comparative statistics
Sevdalis et al.	2008	Developed the Disruptions in Surgery Index to assess operating room professionals' self-perceptions of disruptions that affect surgical processes.	Non-experimental	Observations	Comparative statistics
Sevdalis et al.	2007	Describe the content, initiators, and recipients of communications that intrude or interfere with individual surgical cases. Development of a distraction intensity scale.	Non-experimental	Observation	Descriptive statistics
Spencer et al.	2003	Determine whether there are differences in role-related communication patterns in the ED.	Non-experimental	Observation, audio recording	Descriptive statistics

Table A-9 Continued

Author	*Year*	*Study aim*	*Design*	*Data collection*	*Statistical analysis*
Stamp & Willis	2010	Identify the types and nature of interruptions nurses described pre- and post-implementation of a point-of-care medication administration system.	Non-experimental	Secondary qualitative from prior transcribed observations	Descriptive statistics, qualitative data analysis
Tang et al.	2007	Investigate workflow in intensive care unit remote monitoring.	Non-experimental	Observation	Inferential: multivariate non-otherwise specified
Tang et al.	2004	Investigates nurses' views on the factors contributing to medication errors.	Qualitative	Questionnaire	Descriptive statistics,Qualitative data analysis
Tomietto et al	2012	Evaluate the effectiveness of a hospital-based, multi-intervention program including (1) a dedicated room for medication preparation, (2) a red tabard worn by the nurse responsible for the medication round and (3) education.	Quasi-experimental	Observation	Comparative statistics
Trbovich et al	2010	Assess the nature and frequency of interruptions during medication administration and the interruptions' effects on task efficiency.	Non-experimental	Observation	Descriptive statistics
Tucker	2004	Reports on an in-depth study of operational failures encountered by hospital nurses.	Mixed, non-experimental and qualitative	Observation, interview	Descriptive statistics, qualitative data analysis
Tucker & Spear (sample/data from Tucker 2004)	2006	Describe the work environment of hospital nurses with particular focus on the performance of work systems supplying information, materials, and equipment for patient care.	Mixed, non-experimental and qualitative	Observation, interview, survey	Descriptive statistics, qualitative data analysis
Westbrook et al.	2011	Quantify how nurses distribute their time across tasks, with patients, in individual tasks, and engagement with other health care providers; and how work patterns changed over a two year period.	Non-experimental	Observation	Descriptive statistics

Table A-10 Continued

Author	*Year*	*Study aim*	*Design*	*Data collection*	*Statistical analysis*
Westbrook et al.	2008	Quantify time doctors in hospital wards spend on specific work tasks, and with health professionals and patients.	Non-experimental	Observation, time-motion	Descriptive statistics
Westbrook, Coiera et al.	2010	Measure the association between emergency doctors' rates of interruption and task completion times and rates.	Non-experimental	Observation, time-motion	Descriptive statistics
Westbrook, Woods et al.	2010	Test the hypothesis that interruptions during medication administration increase errors.	Non-experimental	Observation	Inferential: logistic regression
Wolf et al.	2006	Better understand nursing activities and working conditions.	Mixed, non-experimental and qualitative	Observation	Descriptive statistics, qualitative data analysis

Table A-2

Characteristics of Interruptions

Author(s)	*Year*	*Setting (#) unit-if provided*	*Participants (#)*	*Process interrupted*	*Interruption frequency or rate*
Alvarez & Coiera	2005	Hospital: intensive care unit	Nurses (3) Physicians (6)	Ward rounds	16.7/hr
Anthony et al.	2010	Hospital: intensive care units (2)	Nurses	Medication preparation	PRE: 31.8% POST: 18.8%
Ballerman et al.	2011	Hospitals (2): intensive care units (1 pediatric; 1 adult)	Nurses (47); Physicians (18), Resp. Therapist (25), Unit clerks (10)	Patient care	NURSE 3.3/hr PHYSICIAN 3.8/hr RT 3.5/hr UNIT CLERK 4.4/hr
Bennet et al.	2006	Hospital	Nurses (31), Pharmacits (1), Pharm technicians (9)	Medication administration	PRE: 14/nurse POST: 5/nurse
Biron et al.	2009	Hospital: medical unit	Nurses (18)	Medication administration	6.3/hr
Brixey et al.	2008	Emergency department	Nurses (8), Physicians (5)	Patient care	PHYSICIAN: 10/hr NURSE: 12/hr
Brixey et al.	2007	Emergency department	Physicians (5) Nurses (8)	Patient care	not reported
Chisholm et al.	2000	Emergency department, primary care office	Physicians (22)	Patient care	# interruptions: 30.9 # of break-in-task: 20.7

Table A-2 Continued

Author(s)	*Year*	*Setting (#) unit-if provided*	*Participants (#)*	*Process interrupted*	*Interruption frequency or rate*
Chisholm et al.	2001	Emergency departments (multiple hospitals)	Physicians (30)	Patient care	EMERGENCY PHYSICINS: 9.7/hr break-in-task=5.4 PCP 3.9/hr break-in-task=1.8
Coiera & Tombs	1998	Hospital	Nurses (2) Physicians (8)	Patient care	1.04/hr
Coiera et al.	2002	Emergency departments (multiple hospitals)	Physicians (6) Nurses (6)	Patient care	NURSE: 11.2/hr PHYSICIAN: 11.1/hr;
Dearden et al.	1996	Office	Physician (1), Patients (102)	Patient care	10.2 % consultations
Ebright et al.	2003	Hospitals (2): units (7)	Nurses (8)	Patient care	3.2/hr
Edwards et al.	2009	Hospitals (2): emergency department and internal medicine unit	Nurses (2), Physicians (7)	Patient care	D: 22% of time N: 20.4% of time
Elfering et al	2011	Hospitals (11)	Nurses (96)	Patient care	Not reported
Elganzouri et al	2009	Hospitals (3): medical-surgical units	Nurses (151)	Patient care	1.2/medication pass

Table A-2 Continued

Author(s)	*Year*	*Setting (#) unit-if provided*	*Participants (#)*	*Process interrupted*	*Interruption frequency or rate*
Fairbanks et al.	2007	Emergency department	Nurses (4) Medical team (16)	Patient care	ADULT ER: PHYSICIAN: 6.9/hr NURSE: 0.5/hr PEDIATRIC ER: PHYSICIAN: 3.6/hr NURSE: 0.3/hr
Flynn et al.	1999	Hospital: pharmacy	Pharmacists (12), Pharmacy techs (10)	Medication dispensing	# interruptions 2022 # distractions 2457
France et al.	2005	Emergency department	Physicians (10)	Patient care	5.3/hr
Freeman et al	2013	Hospital: cardiac unit	Nurses	Medication administration	PRE: 3.29/round POST: 1.18/round
Friedman et al.	2005	Emergency department	Physicians (11)	Patient care	4.35/hr
Fry & Dacey	2007	Hospital: multiple units (15)	Nurses (139)	Patient care	Not reported
Grundgeiger et al.	2010	Hospital: intensive care unit	Nurses (9)	Patient care	20.8/hr
Harvey et al.	1994	Hospitals (2): medical units (15)	Pharmacists (10), Nurses	Patient care	1.4/hr
Healey et al.	2006	Operating room/Surgical	Surgical team	Surgery	17.4/hr
Healey et al.	2007	Operating room/Surgical: Urology	Surgical team	Surgery	27/hr

Table A-2 Continued

Author(s)	*Year*	*Setting (#) unit-if provided*	*Participants (#)*	*Process interrupted*	*Interruption frequency or rate*
Hedberg & Larsson	2004	Multiple non-specifed	Nurses (6)	Patient care	2.8/hr
Hillel & Vicente	2003	Hospital: post-anaesthesical care unit	Nurses (10)	Patient care	2-25 total
Hillsden & Fenton		Hospital	Nurses	Medication administration	35% total time
Kalisch & Aebersold	2010	Hospitals (2): multiple units (7)	Nurses (35)	Patient care	10/hr
Kliger et al	2009	Hospitals (7)	Nurses	Medication administration	Not reported
Kosits & Jones	2011	Emergency departments (3)	Nurses (30)	Patient care	3.3/hr
Kreckler et al.	2008	Hospital: surgical unit	Nurses	Medication rounds	11% drug rounds
Laxmisan et al.	2007	Emergency department	Physicians	Patient care	Not reported
Liu & Grundgeiger et al.	2009	Simulated Operating Room	Physicians (12)	Surgery	Not reported
Luketich et al.	2002	Operating room/Surgical	Surgical team	Surgery	PRE: 15.3/HR POST: 0.33/hr
Lyons Brown et al.	2007	Emergency department	Nurses (15)	Emergency department triage	5.1/hr
Manias et al.	2002	Hospital: post-surgical	Nurses (12)	Pain management	10.3/hr
McGillis Hall, Ferguson-Pare, et al.	2010	Hospitals (9): medical-surgical units (36)	Nurses (473)	Patient care	4.5/hr
McGillis Hall, Pedersen, & Fairley	2010	Hospitals (3): 6 medical-surgical units	Nurses (30)	Patient care	3.5/hr
McGillis Hall, Pedersen, Hubley, et al.	2010	Hospital: pediatric units (4)	Nurses (32)	Patient care	13.9/hr

Table A-2 Continued

Author(s)	*Year*	*Setting (#) unit-if provided*	*Participants (#)*	*Process interrupted*	*Interruption frequency or rate*
Palese et al.	2009	Hospital: Surgical	Nurses (28)	Medication preparation, administration, and verification	1/3.2 medicaitons
Pape	2003	Hospital medical-surgial unit	Nurses (24)	Medication administration	PRE: 60.5 POST 1: 22.5 POST 2:8 with vest
Pape et al.	2005	Multiple non-specifed	Nurses (20)	Medication administration	Not reported
Popescu et al.	2011	Hospital: medical ward and surgical wards	Nurses (11)	Medication administration	Not reported
Potter et al.	2004	Hospital	Nurse (1) Patient care tech (1)	Patient care	4.3/hr
Potter et al.	2005	Hospitals	Nurses (7)	Patient care	3.4/hr -- 5.9/hr
Redding & Robinson	2009	Hospital: medical-surgical units	Nurses (32)	Patient care	244 total
Relihan et al.	2010	Hospital: medical unit	Nurses (31), Pharmacist (1), Pharmacy techs (9)	Medication administration	PRE: 26/hr POST: 11.4/hr
Rhoades et al.	2001	Outpatient	Pharmacists (22)	Patient care	Not reported
Scott-Cawiezell et al.	2007	Nursing homes	Nurses (20)	Medication administration	0.45/hr
Sevdalis et al.	2007	Operating room	Physicians (16), Nurses (26), Anesthesia staff (20)	Surgery	3.48/procedure
Sevdalis et al.	2008	Operating room	Surgical team	Surgery	Not reported
Spencer et al.	2003	Emergency department	Nurses (4)Physicians (4)	Patient care	15/hr (all)RN SHIFT COORDINATOR: 26.5/hrRNs WITH PATIENT: 17/hr

Table A-2 Continued

Author(s)	*Year*	*Setting (#) unit-if provided*	*Participants (#)*	*Process interrupted*	*Interruption frequency or rate*
Stamp & Willis	2010	Hospital	Nurses (40)	Patient care	Not reported
Tang et al.	2007	Hospital: intensive care unit	Nurses (7)	Patient care	7.5 /h
Tang et al.	2004	Multiple non-specifed	Nurses (72)	Patient care	Not reported
Tomietto et al	2012	Hospital: surgical units (7)	Nurses	Medication rounds	PRE: 1 per 3.2 medications POST: 1 per 2.3 medications
Trbovich et al	2010	Hospital: chemotherapy unit	Nurses (17)	Medication administration	14/hr
Tucker	2004	Hospitals (9)	Nurses (26)	Patient care	Not reported
Tucker & Spear	2006	Hospitals (6)	Nurses (531)	Patient care	0.8/hr
Westbrook et al.	2011	Hospital: multiple units (2)	Physicians (19)	Patient care	1.9/hr
Westbrook et al.	2008	Hospital: multiple units (4)	Nurses (57)	Patient care	2.86/hr
Westbrook, Coiera et al.	2010	Hospital: multiple units (# not specified)	Physicians (44)	Patient care	6.6/hr
Westbrook, Woods et al.	2010	Hospitals (2): units (6)	Nurses (98)	Medication administration	53.1% medications
Wolf et al.	2006	Hospital: multiple units (# not specified)	Nurses (7)	Patient care	3.4/hr

**hourly rate calculated by author (total # interruptions/total hours) when not provided in original article*

Table A-3

Primary and Secondary Tasks

Author(s)	*Primary Task Interrupted*	*Secondary Task (i.e. what the interrupted provider is asked to do)*
Alvarez & Coiera (2005)	Not specified	Communication
Ballerman et al. (2011)	Communication, indirect care, direct care, documentation, transit, medication, social, pager, supervision, administrative tasks	Communication, indirect care, direct care, documentation, transit, medication, social, pager, supervision, administration
Biron et al. (2009)	Medication adminstration round	Direct care, indirect care, unit related tasks, and personal
Ebright et al. (2003)	Supply, equipment or medication retrieval	Not specified
Flynn et al. (1999)	Not specified	Prescription-processing questions, staff looking up at people passing by
France et al. (2005)	Face-to-face nursing interruptions most frequently interrupted exchanging patient information tasks, electronic white-board interactions, and charting. Phone interruptions most frequently interrupted exchanging patient information tasks, direct patient care and charting.	Not specified
Grundgeiger et al. (2010)	Documentation, patient related tasks, safety check, medication	Not specified
Harvey et al. (1994)	Direct patient encounter, intern's sleep, face-to-face and telephone communication with nurses and other staff, recreation & reading	Request for medicaiton order, patient assessment, lab results, venipuncture or IV start, death pronouncement, resuscitation, wrong number paged

Table A-3 Continued

Author(s)	*Primary Task Interrupted*	*Secondary Task (i.e. what the interrupted provider is asked to do)*
Hedberg & Larsson (2004)	Direct patient care (bed-making, checks, conversation, dressing, feeding, medication admin, patient hygeine, prparing); Indirect care (after round work, documentation, phone calls, rounds, sorting papers); breaks, transit	Exchange of information, instructions, assistance
Hillel & Vicente (2003)	Not specified	Phone call, move away from x-ray machine, talk to patient, help another nurse, give report, care for another patient, listent to verbal report, answer a question
Hillsden & Fenton (2006)	Not specified	Patient need (repositioning, medication education, breakthrough analgesia request); communicating with relatives and issues relating to staff, medication not being replaced appropriately, patient requests
Kalisch & Aebersold (2010)	Communication, documentation, medication administration, interventions, planning care, assessment, unit management, and other	Give or receive a request, give information or receive information
Kosits & Jones (2011)	Not specified	Documentation (medical record, computer), medication (preparation, retrieval, administration, order review), venipuncture, communication (patient interview, patient report, case discussion, telephone call), vital signs, physcial assessment, IV start, IV other, data anlaysis
Kreckler et al. (2008)	Medication rounds	Deliver care, seek eqipment or information, discuss patient, management and coordination, equipment attention, talk to patient, other
Liu & Grundgeiger et al. (2009)	Hanging blood	Request for patient transfer

Table A-3 Continued

Author(s)	*Primary Task Interrupted*	*Secondary Task (i.e. what the interrupted provider is asked to do)*
Luketich et al. (2002)	Not specified	Equipment adjustment
Manias et al. (2002)	Responding to request for analgesia	Administering antibiotics, answering or making telephone calls, assisting nursing students with patient care, and searching for equipment
McGillis Hall, Ferguson-Pare, et al. (2010)	Documentation, patient care, medication preparation and administration, transit, communication, housekeeping & clerical tasks	**Distractions caused by**: environmental noise, communication; **intrusions caused by**: consultation assistance, telephone, pagers, call bells; **discrepancies caused by**: missing/misplaced/broken supplies or equipment, need clarification
McGillis Hall, Pedersen, and Fairley (2010)	Patient care, documentation, medication, communication, transit, housekeeping/clerical	Communication related to patient care, waiting/looking for other things, patients, environmental noise
McGillis Hall, Pedersen,Hubley, et al. (2010)	Patient care, documentation, transit, medication, consulting, break, IV starts and care, communication, equipment supplies, lab work, housekeeping/clerical, universal precautions, telephone	Communication with the nurse related to patient care, monitors or pumps, the need for assistance, socializing, telephone calls for the nurse or patient, pagers, another health care provider, and call bells
Palese et al. (2009)	Not specified	Obtaining additional supplies, patient requests, staff communication, other care duties, assisting other staff, documentation, emergencies
Potter et al. (2004)	Interventions (administering medications, problem-solving IV start and care, and teaching patients); assessment; medication preparation	Not specified

Table A-3 Continued

Author(s)	*Primary Task Interrupted*	*Secondary Task (i.e. what the interrupted provider is asked to do)*
Potter et al. (2005)	Assessment, planning, and nurse interventions	Staff inquiries (seeking information from RN), staff communications (sharing unit management information), and equipment or resource access
Sevdalis et al. (2007)	Not specified	Teaching, attend to Equipment/provisions, Irrelevant conversation by team staff or external staff, attending staff, answer phone calls or bleeps
Spencer et al. (2003)	Not specified	Patient management (irect and indirect)
Trbovich et al (2010)	Tasks of medication administration: traveling, preparation, medication delivery, charting, communication, and verification Safety critical sub-tasks: drug verification (electronic and paper), vital sign check, pump programming, IV push, armband check	Perform double-checks, repond to questions, complaints, statements, and alarms
Westbrook et al. (2008)	Medication tasks, documentation, communication	Not specified
Westbrook, Coiera et al. (2010)	Documentation (discharge summary documentation tasks and other documentation tasks), direct and indirect patient care, communication, social activities.	Not specified

Table A-4

Sources of Interruptions

Author (Year)	Communication: Non-Face-to-Face	Communication: Care team	Communication: Patient	Communication: Family	Equipment: Alarm	Equipment /Supply: Failure	Equipment: Non-specified	Environ-ment	Self
Alvarez & Coiera (2005)		X							
Anthony et al. (2010)	X								X
Biron et al. (2009)		X	X		X	X			X
Brixey et al. (2008)	X					X			X
Chisholm et al. (2001)	X		X						
Coiera & Tombs (1998)	X	X							
Collins et al. (2007)									
Dearden et al. (1996)	X								
Ebright et al. (2003)		X	X	X					
Edwards et al. (2009)		X	X	X					
Elganzouri et al (2009)		X				X			
Flynn et al. (1999)		X	X						
France et al. (2005)	X	X				X			
Freeman et al (2013)	X	X	X	X	X				
Friedman et al. (2005)	X	X	X	X					
Fry & Dacey (2007)	X	X	X						
Grundgeiger et al. (2010)		X	X				X		
Harvey et al. (1994)	X								
Healey et al. (2006)	X	X					X	X	
Healey et al. (2007)	X	X					X	X	
Hedberg & Larsson (2004)		X	X	X				X	
Hillel & Vicente (2003)	X	X	X		X				
Kalisch & Aebersold (2010)	X	X	X	X					
Kosits & Jones (2011)	X	X	X	X					

Table A-4 Continued

Author (Year)	Communication: Non-Face-to-Face	Communication: Care team	Communication: Patient	Communication: Family	Equipment: Alarm	Equipment /Supply: Failure	Equipment: Non-specified	Environ-ment	Self
Kreckler et al. (2008)	X	X	X	X	X				
Laxmisan et al. (2007)	X	X							
Luketich et al. (2002)							X		
Lyons Brown et al. (2007)	X	X	X	X					
Manias et al. (2002)	X	X				X			
McGillis Hall, Ferguson-Pare, et al. (2010)		X	X	X				X	X
McGillis Hall, Pedersen,and Fairley (2010)		X	X	X		X		X	X
McGillis Hall, Pedersen, Hubley, et al. (2010)		X						X	X
Palese et al. (2009)	X	X							
Pape (2003)	X		X	X		X		X	
Pape et al. (2005)		X		X		X		X	
Popescu et al. (2011)		X							
Potter et al. (2004)	X	X	X	X		X			
Potter et al. (2005)	X	X				X			
Redding & Robinson (2009)	X		X			X		X	
Relihan et al. (2010)		X	X	X		X		X	
Sevdalis et al. (2007)	X	X							
Spencer et al. (2003)	X								
Tang et al. (2007)		X			X				X
Tomietto et al (2012)		X	X			X			
Trbovich et al (2010)		X	X	X	X				
Tucker & Spear (2006)	X					X			
Tucker (2004)						X			

Appendix B—Nurse Questionnaire

Thank you for agreeing to participate in this study. This short questionnaire should take approximately 15-30 minutes. All data collected in this questionnaire will be kept confidential. It will be stored in a manner in which the information you provide cannot be linked to your name. Your data will never be reported in such a way that your personal information could be identified.

Demographics. Let's begin with some basic demographics.

1. First Name_____
2. Last Name_____
3. As a Registered Nurse, what is your highest education level?

a. Professional Diploma
b. Associate's Degree
c. Bachelor's Degree
d. Master's Degree

1. How long have you worked on this hospital unit? _____ years _____ months
2. How long have you worked as a nurse? _____ years _____ months
3. How old are you? _____
4. With which gender do you identify?

a. Male
b. Female
c. Trans
d.
e.
f. Other

Characteristics. Next, we'd like to learn a little bit more about you, your work style, and how you respond to work stress, like interruptions.

For the following Items, consider your feelings over the past few months. Please rate the extent to which you agree or disagree with the following statements. For each question choose from the following alternatives:

0=Strongly Disagree
1= Moderately Disagree
2=Slightly Disagree
3=Slightly Agree
4= Moderately Agree
5=Strongly Agree

Appendix B Continued

This first set of statements relates to your work style (CONSCIENTIOUSNESS).
Please rate the extent to which you agree or disagree with the following statements.

In general, when I work . . .

	Strongly Disagree	*Moderately Disagree*	*Slightly Disagree*	*Slightly Agree*	*Moderately Agree*	*Strongly Agree*
I am always prepared.	⓪	①	②	③	④	⑤
I pay attention to details.	⓪	①	②	③	④	⑤
I get chores done the right way.	⓪	①	②	③	④	⑤
I follow a schedule.	⓪	①	②	③	④	⑤
I like order.	⓪	①	②	③	④	⑤
I am exacting in my work.	⓪	①	②	③	④	⑤
I leave my belongings lying around.	⓪	①	②	③	④	⑤
I make a mess of things.	⓪	①	②	③	④	⑤
I often forget to put things back in their proper place.	⓪	①	②	③	④	⑤
I shirk my duties.	⓪	①	②	③	④	⑤

Appendix B Continued

This next set of statements relates to how you generally think about stress (STRESS MINDSET).

Please rate the extent to which you agree or disagree with the following statements. Broadly speaking, when I think about stress, I think . . .

	Strongly Disagree	*Moderately Disagree*	*Slightly Disagree*	*Slightly Agree*	*Moderately Agree*	*Strongly Agree*
The effects of stress are negative and should be avoided.	⓪	①	②	③	④	⑤
Experiencing stress facilitates my learning and growth.	⓪	①	②	③	④	⑤
Experiencing stress depletes my health and vitality.	⓪	①	②	③	④	⑤
Experiencing stress enhances my performance and productivity.	⓪	①	②	③	④	⑤
Experiencing stress inhibits my learning and growth.	⓪	①	②	③	④	⑤
Experiencing stress improves my health and vitality.	⓪	①	②	③	④	⑤
Experiencing stress debilitates my performance and productivity.	⓪	①	②	③	④	⑤
The effects of stress are positive and should be utilized.	⓪	①	②	③	④	⑤

Appendix B Continued

This final set of statements relates to how you might bounce back from stressors you experience at work (PYSCHOLOGICAL RESILIENCE).
Please rate the extent to which you agree or disagree with the following statements.

	Strongly Disagree	*Moderately Disagree*	*Slightly Disagree*	*Slightly Agree*	*Moderately Agree*	*Strongly Agree*
Despite setbacks, I remain committed to accomplishing job tasks.	⓪	①	②	③	④	⑤
When necessary, I am willing to work extra hard.	⓪	①	②	③	④	⑤
When a problem occurs at work, I am usually able to deal with it.	⓪	①	②	③	④	⑤
I am in control of most things that happen to me at work.	⓪	①	②	③	④	⑤
I enjoy facing new challenges at work.	⓪	①	②	③	④	⑤
I am able to cope with unexpected problems at work.	⓪	①	②	③	④	⑤

APPENDIX 4A. Nurse Questionnaire (Continued)

Thank you for taking this questionnaire! Now please click <u>here</u> [hyperlink to Google Form] to schedule a time for the researcher to observe you at work.

NB: This documents is a simulation of what nurses actually saw. The questionnaire was administered electronically. For the purposes of IRB review, nurse state and trait characteristics appear in CAPS at the end of each introductory sentence. These CAPS words did not appear in the actual electronic questionnaire.

Appendix C—Daily Pre-Shift Survey

Pre –Shift Nurse-Level Measures (Collected at start of observation period, prior to initiation of patient care)

For each of the following questions, please identify the extent to which you agree with each statement at this moment.
For each question choose from the following alternatives:

0=Strongly Disagree
1= Moderately Disagree
2=Slightly Disagree
3=Slightly Agree
4= Moderately Agree
5=Strongly Agree

1. **Pre-Shift Stress**

At this moment, I fell that I . . .	Strongly Disagree	Moderately Disagree	Slightly Disagree	Slightly Agree	Moderately Agree	Strongly Agree
Am unable to control the important aspects of my patient's care.	0	1	2	3	4	5
Can successfully deal with irritating hassles when handling my patient's care.	0	1	2	3	4	5
Things were going my way**.**	0	1	2	3	4	5
Fee difficulties are piling up so high that I cannot overcome them.	0	1	2	3	4	5

Appendix C Continued

Pre-Shift Affect

At this moment I feel . . .	Strongly Disagree	Moderately Disagree	Slightly Disagree	Slightly Agree	Moderately Agree	Strongly Agree
Anger	0	1	2	3	4	5
Frustration	0	1	2	3	4	5
Anxiety	0	1	2	3	4	5
Irritation	0	1	2	3	4	5
Sadness	0	1	2	3	4	5

At this moment I feel . . .	Strongly Disagree	Moderately Disagree	Slightly Disagree	Slightly Agree	Moderately Agree	Strongly Agree
Calm	0	1	2	3	4	5
Excited	0	1	2	3	4	5
Happy	0	1	2	3	4	5
Proud	0	1	2	3	4	5

Appendix D—Episodic Survey and Task Checklists

Planned Task Checklist*

Planned Tasks**	Completed Tasks
☐ medication preparation	☐ medication preparation
☐ charting	☐ charting
☐ diagnostic test result review	☐ diagnostic test result review
☐ patient history review	☐ patient history review
☐ physical assessment	☐ physical assessment
☐ medication administration	☐ medication administration
☐ oral hygiene	☐ oral hygiene
☐ skin care	☐ skin care
☐ IV/peripheral/central line care	☐ IV/peripheral/central line care
☐ wound care	☐ wound care
☐ patient (and/or family member) education	☐ patient (and/or family member) education
☐ comforting and/or talking with patient	☐ comforting and/or talking with patient
☐ developing and/or updating care plan	☐ developing and/or updating care plan
☐ preparing patients and families for discharge	☐ preparing patients and families for discharge

***nurse completes left half of checklist**

Appendix D Continued

Episodic Surveys (Collected prior to the first care episode and immediately following each care episode)
For each of the following questions choose from the following:

0=Strongly Disagree
1= Moderately Disagree
2=Slightly Disagree
3=Slightly Agree
4= Moderately Agree
5=Strongly Agree

Perceived Stress Scale

To what extent do you agree with the following statement?

When in the room with my patient . . .	Strongly Disagree	Moderately Disagree	Slightly Disagree	Slightly Agree	Moderately Agree	Strongly Agree
I was unable to control the important aspects of my patient's care.	0	1	2	3	4	5
I successfully dealt with irritating hassles when handling my patient's care.	0	1	2	3	4	5
I felt things were going my way when handling my patient's care.	0	1	2	3	4	5
I felt difficulties were piling up so high that I could not overcome them when handling my patient's care.	0	1	2	3	4	5

Emotion

At this moment I feel . . .	Strongly Disagree	Moderately Disagree	Slightly Disagree	Slightly Agree	Moderately Agree	Strongly Agree
Anger	0	1	2	3	4	5
Frustration	0	1	2	3	4	5
Anxiety	0	1	2	3	4	5
Irritation	0	1	2	3	4	5
Sadness	0	1	2	3	4	5

At this moment I feel . . .	Strongly Disagree	Moderately Disagree	Slightly Disagree	Slightly Agree	Moderately Agree	Strongly Agree
Calm	0	1	2	3	4	5
Excited	0	1	2	3	4	5
Happy	0	1	2	3	4	5
Proud	0	1	2	3	4	5

Appendix D Continued

Completed Task Checklist

Planned Tasks	**Completed Tasks****
☐ medication preparation	☐ medication preparation
☐ charting	☐ charting
☐ diagnostic test result review	☐ diagnostic test result review
☐ patient history review	☐ patient history review
☐ physical assessment	☐ physical assessment
☐ medication administration	☐ medication administration
☐ oral hygiene	☐ oral hygiene
☐ skin care	☐ skin care
☐ IV/peripheral/central line care	☐ IV/peripheral/central line care
☐ wound care	☐ wound care
☐ patient (and/or family member) education	☐ patient (and/or family member) education
☐ comforting and/or talking with patient	☐ comforting and/or talking with patient
☐ developing and/or updating care plan	☐ developing and/or updating care plan
☐ preparing patients and families for discharge	☐ preparing patients and families for discharge

***nurse completes right half of checklist**

Appendix E–Variable/Type/Construct/Concept

VARIABLE	TYPE	MEASUREMENT	UNIT (LEVEL) OF ANALYSIS	COLLECTION METHOD	CITATION	TESTED IN FINAL MODELS ?
Control Variables						
Demographics Controls	Continuous and Categorical	Gender, age, education level, tenure, experience	Nurse (Level-2)	One-Time Questionnaire	NA	NO
Pre-Shift Affect	Continuous	Pre-shift positive affect: average of negative emotion items Pre-shift negative affect: average of positive emotion items	Nurse (Level-2)	Daily Survey—at onset of each observation day	Gabriel, Diefendorff, & Erickson (2011)	NO
Pre-Shift Stress	Continuous	Average of items on perceived stress scale	Nurse (level-2)	Daily survey—at onset of each observation day	Cohen, Kamarck, & Mermelstein (1983)	No

Appendix E Continued

VARIABLE	TYPE	MEASUREMENT	UNIT (LEVEL) OF ANALYSIS	COLLECTION METHOD	CITATION	TESTED IN FINAL MODELS ?
Cross-Level Moderators						
Stress Mindset	Continuous	Average of items on Stress Mindset scale	Cross-Level	One-Time Questionnaire	Crum, Salovey, & Achor (2013)	YES
Psychological Resilience	Continuous	Average of items on Resilience scale	Nurse (Level-2)	One-Time Questionnaire	Cole, Bruch, & Vogel (2006)	YES
Conscientiousness	Continuous	Average of items on Conscientiousness scale	Nurse (Level-2)	One-Time Questionnaire	Goldberg (1999)	YES

Appendix E Continued

VARIABLE	TYPE	MEASUREMENT	UNIT (LEVEL) OF ANALYSIS	COLLECTION METHOD	CITATION	TESTED IN FINAL MODELS ?
Independent Variable						
Room-Type	Categorical	Single-occupancy; double-occupancy	Episode (Level-1)	Observation	NA	YES
Mediator						
Interruptions	Continuous	Observable events which direct the nurse's attentional focus away from the care task at hand, excluding communication interruptions that were initiated by the patient	Episode (Level-1)	Observation	Beal, Weiss, Barros, & MacDermid (2005)	YES

Appendix E Continued

VARIABLE	TYPE	MEASUREMENT	UNIT (LEVEL) OF ANALYSIS	COLLECTION METHOD	CITATION	TESTED IN FINAL MODELS ?
Dependent Variables						
Task Completion	Continuous	Nurse Task Inventory (% of tasks completed out of total planned tasks)	Episode (Level-1)	Episodic Survey	Aiken, Clarke, Sloane, et al. (2001)	YES
MAE Rate	Continuous	Numerator=number of doses having 1 or more types of MAEs Denominator=total number of doses scheduled plus any extra doses given	Episode (Level-1)	Observation/ Electronic Medical Record	Allan, Barker (1990)	YES
Perceived Stress	Continuous	Average of items on Perceived Stress scale	Episode (Level-1)	Episodic Survey	Cohen, Kamarck, & Mermelstein (1983)	YES
Positive Affect	Continuous	Average of positive emotion items	Episode (Level-1)	Episodic Survey	Gabriel, Diefendorff, & Erickson (2011)	YES
Negative Affect	Continuous	Average of negative emotion items	Episode (Level-1)	Episodic Survey	Gabriel, Diefendorff, & Erickson (2011)	YES

Appendix F – Nurse-Level Scale Correlations

Conscientiousness Scale Interitem Correlations

		1	2	3	4	5	6	7	8	9	10
1	I am always prepared.	1									
2	I pay attention to details.	.416	1								
3	I get chores done the right way.	.414	.840	1							
4	I follow a schedule.	.220	.524	.521	1						
5	I like order.	.624	.714	.711	.407	1					
6	I am exacting in my work.	.434	.541	.771	.518	.541	1				
7	I leave my belongings lying around.*	.139	.478	.326	.378	.391	.074	1			
8	I make a mess of things.*	.443	.645	.434	.060	.461	.192	.594	1		
9	I often forget to put things back in their proper place.*	.294	.658	.393	.182	.395	.224	.552	.838	1	
10	I shirk my duties.*	.416	.429	.194	.175	.286	.000	.130	.461	.483	1

*indicates items that were reverse scored

Stress Mindset Scale Interitem Correlations

		1	2	3	4	5	6	7	8
1	The effects of stress are negative and should be avoided.*	1							
2	Experiencing stress facilitates my learning and growth.	.143	1						
3	Experiencing stress depletes my health and vitality.*	.118	.586	1					
4	Experiencing stress enhances my performance and productivity.	.150	.852	.341	1				
5	Experiencing stress inhibits my learning and growth.*	.379	.884	.598	.673	1			
6	Experiencing stress improves my health and vitality.	.099	.626	.604	.583	.505	1		
7	Experiencing stress debilitates my performance and* productivity.	.288	.655	.559	.667	.688	.437	1	
8	The efforts of stress are positive and should be utilized.	.238	.430	.139	.691	.310	.503	.576	1

*indicates items that were reverse scored

Appendix F Continued

Psychological Resilience Scale Interitem Correlations

		1	2	3	4	5	6
1	Despite setbacks, I remain committed to accomplishing job tasks.	1					
2	When necessary, I am willing to work extra har.	.640	1				
3	When a problem occurs at work, I am usually able to deal with it.	.524	.324	1			
4	I am in control of most things that happen to me at work.	.148	.300	.236	1		
5	I enjoy facing new challenges at work.	.154	.170	.113	.055	1	
6	I am able to cope with unexpected problems at work	.694	.682	.630	.401	.206	1

Vita

Jenniger (Jen) Early is a Senior Project Manager with VCU's Health Division of Community Health. She supports the development of VCU Health System's Population Health strategy. Jen is a registered nurse by training, and has over a decade of community health and care coordination experience. She also has expertise in community engagement, anchor mission advancement, community-engaged research, and dialogue facilitation for innovation. She enjoys working with academic health systems as they align their resources with their surrounding communities to improve population health. Jen earned both her B. S. in Nursing and her M.S. in Health Administration from VCU.