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RELATIONSHIP AMONG SUBJECTIVE MENTAL WORKLOAD, EXPERIENCE, AND EDUCATION OF CARDIOVASCULAR CRITICAL CARE REGISTERED NURSES

by

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A DISSERTATION

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ABSTRACT OF DISSERTATION
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Subjective mental workload was introduced for study in nursing emanating from a concern among nurses that current measures of nursing workload fail to capture the cognitive demands of patient care. Subjective mental workload is conceptually based on attention load, or the amount of attention that is required versus amount available to cognitively process work information. Information processing theory suggested a relationship between past learning and subjective mental workload; that is, as work becomes more familiar, subjective mental workload decreases. Subjective mental workload had been measured in other populations, but had not been studied in nursing.

The purposes of the study were to: (1) examine the validity and reliability of NASA TLX for use among cardiovascular critical care nurses; and, (2) examine subjective mental workload and its relation to specialty experience, general experience, and education of registered nurses in cardiovascular critical care units. A three-stage study

was conducted. Initially, twenty nursing experts from the eastern U.S. were surveyed to determine the content validity of NASA TLX for use among critical care nurses. A pilot study of twenty nurses was conducted to test proposed methodology. A descriptive level correlation design was used in the principal study which was conducted across four medical centers in the southeastern U.S. Seventy nurses were randomly selected and stratified by unit (CCU, CVICU). Subjects in both the pilot and principal studies were licensed registered nurses, employed as a staff nurses and routinely assigned to care for adult cardiovascular critical care patients.

Suggestions made by the nursing experts resulted in a content valid instrument for measuring the subjective mental workload of critical care nurses. Cronbach alpha was assessed at 0.82. Subjects reported an average subjective mental workload of 4.3 following the first four hours of patient care. Findings from the principal study suggested no statistically significant relationship between or among specialty experience, general experience, education, and subjective mental workload. Post hoc analysis revealed significant relationships between subjective mental workload and patient diagnosis, volume of assigned patients, and number of days off from work.

Abstract Approved by: Committee Chairman Dena Sanders

Program Director Elizabeth Stallings

Date 7/1/93 Dean of Graduate School W. A. Dorman

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CHAPTER I

Introduction

A decrease in the length of stay among hospitalized patients and a steady increase in the complexity of health care and technology have led to an escalation in patient acuities and an increased demand on hospital nurses (Bowen, 1988). It has become imperative to assess and evaluate the workload of nurses due to the shortage of nurses available to meet these advancing care demands in hospitals. Much has been written related to the current workload of nurses and how that workload might be reduced (Merker & Elbein, 1991). The Commission on Nursing has identified the need to examine both workload and measures which could be implemented to reduce that workload (Bowen, 1988). Despite a widespread effort by hospitals to increase their market share of nurses and to reduce nursing workload, national nurse vacancy rates among hospitals have remained at 11 percent (Roberts, 1992).

Workload in the literal sense means that work is loaded onto someone or something (Hart, 1987). The work of nurses in clinical practice is patient care. Nursing load has been defined as the time required to provide nursing care to patients, or hours per patient day (HPPD).

Historically, hospital nursing administrators have measured the work of clinical nurses using patient classification systems. Patients have been classified by the number and types of nursing interventions that are required for care (factor systems), by categories of common characteristics (prototype systems), and by nursing intensity (acuity of illness systems) (Jennings, Rea, Antopol & Carty, 1989). Industrial engineering techniques, such as time and motion studies, have been employed to apply time parameters (HPPD) to these different patient classification systems. Hospital nursing administrators have used the total HPPD from each nursing unit to project nurse staffing requirements and as a basis for assessing nursing productivity.

Clinical nurses have expressed the concern that the mental demands of patient care are not measured by current workload methods (Jennings, Rea, Antopol & Carty, 1989; Meierhoffer, 1991; Reitz, 1985). King (1975) has argued that industrial engineering models of workload are too reductionistic and do not depict the total cognitive domain of nursing practice. These concerns have applied particularly in critical care units where the acuity of illness is high, the turnover among patients is rapid, and nurses must mentally process a vast amount of changing information from patients, automated systems (cardiac monitors, respirators, infusion pumps), and other health care providers (Dracup, 1987; Roberts, Minnick, Ginzberg & Curran, 1989).

A conceptualization of workload that has not been considered by nursing, but one that has been used to address the cognitive demands of work experienced by individuals, is mental workload. Mental workload has been defined as the attention cost incurred by a worker in response to work demands (Hart & Staveland, 1988). The theoretical basis of mental workload is believed to be attention load (Gopher & Donchin, 1986; Meshkati & Lowenthal, 1988; O'Donnell & Eggemeir, 1986). Information processing theorists have contended that attention is required to mentally process information, but that attention capacity, or amount of available attention, in humans is fixed (Logan, 1988; Miller, 1956; Shriffrin & Schneider, 1977; Wickens, 1984). In other words, a person can only think about so many things at one time.

Surveys of workers from different occupations and educational backgrounds have revealed that people commonly describe their attention load in terms of the mental, physical and time demands of work, and their responses to those work demands, including effort, performance satisfaction, and frustration (Hart & Staveland, 1988). Instruments, such as the NASA TLX (National Aeronautics Space Administration Task Load Index) have been developed to measure workers' perceptions of mental workload, or subjective mental workload (Human Performance Research Group, 1988). Most studies of subjective mental workload have been conducted in simulated work environments and have

focused on military pilot populations (Hart, 1987). Recently, the subjective mental workload of physicians in both outpatient and hospital settings has been examined (Bertram, 1991; Gaba & Lee, 1990). No studies of subjective mental workload among nurses have been reported.

One variable of mental workload that has been examined in nursing, but not in the context of workload, is work experience. Two basic elements of experiential learning, task consistency and practice, have been postulated in the General Theory of Human Information Processing (GTHIP) as reducing attention load (Shriffrin & Schneider, 1977). Vidulich and Pandit (1986) used the GTHIP and reported lower subjective mental workloads associated with consistent and practiced learning. Research in nursing has suggested that as years of general or specialty experience increase, nurses process patient care information more rapidly and with decreasing emotional demands (Benner, 1984; Benner, Tanner & Chesla, 1992). The scope and amount of patient information processed by a nurse has been shown to increase as years of nursing education increase (Geiger & Davidhizar, 1990; Young, Lehrer & White, 1991). How these variations in the learning backgrounds of nurses influenced their subjective mental workloads when caring for patients has not been studied.

In this research, the validity and reliability of the NASA TLX as a measure of subjective mental workload among critical care nurses is investigated. Subjective mental

workload and its relation to the specialty experience, general experience, and education of cardiovascular critical care registered nurses is examined. Critical care nurses were the focus for study because caring for unstable, acutely ill patients is considered to be more cognitively demanding than caring for more stable, recovering patients. To minimize variations in subjective mental workload due to the work performed by subjects, cardiovascular care units were chosen because of the homogeneity of patient diagnoses found in those units across hospitals.

Problem

The workload assessment of nurses in hospitals has been defined by patient care tasks and measured as the nursing time required to perform those tasks. The problem has been that nursing workload methods do not assess the mental workload experienced by nurses while providing patient care, and subjective mental workload has not been examined in nursing. Subjective mental workload has not been considered by nursing administrators when staffing decisions have been made, when the productivity of a nursing unit have been assessed, or when interventions to reduce nursing workload have been planned.

Significance

The Commission on Nursing has called for the examination of nursing workload and for measures to reduce that workload (Bowen, 1988). The inadequacy of current nursing workload methods for measuring the mental demands of nurses

when providing patient care has been identified in the nursing literature (Jennings, Rea, Antopol & Carty, 1989; King, 1975; Meierhoffer, 1991; Reitz, 1985). This research addressed this deficit by examining the subjective mental workload of registered nurses. Findings from this research have implications for nursing administration, nursing education, and nursing research.

The concept of subjective mental workload provides an expanded view of nursing workload for the nursing administrator. Variables that have been examined using traditional nursing workload measures warrant investigation relative to subjective mental workload. This study began that process. Findings from this study may provide new insight into workload differences other than HPPD between nursing units and among individual nurses. Understanding the variables which contribute to subjective mental workload of nurses may expand current thinking relative to nurse-patient assignments, unit staffing patterns, and nursing productivity.

Although education and experience have been primary considerations in the hiring and placement of nurses in organizations, these individual learning background variables have not been factors in traditional workload measurement. Understanding the relationships between these variables and subjective mental workload may lead to modified orientation programs that are aimed at minimizing the subjective mental workload of new nurses.

This research introduces the concept of subjective mental workload into nursing. While patient outcomes have not been examined in this study, an instrument to measure nursing subjective mental workload has been tested in the clinical practice setting. A beginning data base of variables that influenced and those that did not influence the subjective mental workload of one group of nurses has been documented. Given the critical shortage of registered nurses to meet the current demands of the health care system, consideration of the subjective mental workload currently experienced by nurses is important.

Purpose

The purposes of the research have been to: (1) examine the validity and reliability of the NASA TLX for cardiovascular critical care nurses; and (2) examine subjective mental workload and its relation to specialty experience, general experience, and education of registered nurses in cardiovascular critical care units.

Research Questions

1. What is the content validity of the NASA TLX for registered nurses in cardiovascular critical care units?
2. What is the reliability of the NASA TLX for registered nurses in cardiovascular critical care units?
3. What is the subjective mental workload of registered nurses in cardiovascular critical care units?

4. What is the relationship between subjective mental workload and the specialty experience of registered nurses in cardiovascular critical care units?

5. What is the relationship between subjective mental workload and the general experience of registered nurses in cardiovascular critical care units?

6. What is the relationship between subjective mental workload and the education of registered nurses in cardiovascular critical care units?

7. What is the relationship among the subjective mental workload, specialty experience, general experience, and education of registered nurses in cardiovascular care units?

Theoretical Framework

Most human factors scientists have agreed that the conceptual basis of mental workload is attention load, or the amount of attention that is required versus available to process information (Gopher & Donchin, 1986; Hancock & Meshkati, 1988). Information processing theories have provided alternative explanations for why attention load varies. In this study, the General Theory of Human Information Processing, hereafter referred to as the GTHIP, (Schneider & Shriffrin, 1977; Shriffrin & Schneider, 1977) has been used to explain variations in subjective mental workload related to the learning background of nurses, including specialty experience, general experience, and education.

In this section, the conceptual structures of the theory have been introduced first, followed by an explanation of how information is processed. The theoretical relationship between learning and subjective mental workload has been discussed in the context of this research.

Conceptual Structures

Shriffrin and Schneider (1977) postulated that information is processed by humans using two cognitive structures and two processing modes. The two cognitive structures were identified as the short-term store (STS) which uses a controlled processing mode, and the long-term store (LTS) which uses an automatic processing mode. The STS and the LTS are believed to serve different, but related purposes in the information processing sequence.

Short-Term Store. It was postulated that the short-term store, sometimes called working memory, is used to examine all incoming information from the senses and to form a response (action or inaction) to that information. The capacity of the STS to process information is defined by attention capacity. The attention capacity in humans has been estimated as seven datum or data sets, plus or minus two, at any point in time (Chi, 1978; Miller, 1956). The dependency of the STS on attention capacity requires that information be processed slowly and consciously. Shriffrin and Schneider (1977) have named this slow, conscious method of processing information, the controlled mode. The controlled mode is used to process all information that is new

to an individual. For example, when a nurse encounters a patient with a set of symptoms that she has not seen before, the nurse would theoretically process this information using the controlled mode.

Long-Term Store. The long-term store, or memory bank, is postulated as serving the dual purposes of long-term storage and information processing. Once information has been processed in the STS, it is transferred to the LTS. This transfer of information from the STS to the LTS is defined by the theorists as learning. Learned information is stored in nodal networks (analogous to nerves) within the LTS; these nodal networks are refined or expanded each time similar information is processed. The theorist contend that the nodal networks also enable the long-term store to process information. Shriffrin and Schneider (1977) have labeled the information processing method used by the LTS as the automatic mode. The automatic mode is used to process information that is familiar (same or similar to stored information). Shiffrin and Schneider believed that because the automatic mode was not dependent on attention capacity, it could process information very rapidly and could operate in parallel to the controlled mode. For example, when a nurse cares for a patient whose set of symptoms are very familiar to her, she may be able to perform nursing tasks, monitor the patient, and at the same time, talk with the patient or family.

The Processing of Information

Information is received from the environment through the senses (auditory, visual, touch, olfactory, taste). According to the GTHIP, a probe, or request, for related information is sent to the LTS (Shriffrin & Schneider, 1977). Analogous to a librarian, the LTS is requested to search the nodal networks for previously learned information and to respond to the probe with the most related information.

The probe data and the incoming sensory data are then examined together as a set in the STS, and an action (inaction) response is made. When probe and sensory data are new or only partially related, the controlled mode is used to consciously examine the information set (probe and sensory data) and to determine a response. If the probe data are consistent (same) with the sensory data, the information set is sent to the LTS for automatic processing and storage. To the degree that information can be processed by the automatic mode in the LTS, the demand on attention capacity of the STS, or attention load, is decreased (Shriffrin & Schneider, 1977).

The GTHIP and Nursing

The GTHIP has provided a plausible explanation of how nurses process patient care information, and how previous learning by the nurse may influence the amount of attention that is required to provide nursing care. Three ways that the nurses in this study have previously learned to care

for patients (education, specialty and general experience) are examined relative to subjective mental workload.

A general premise of the GTHIP is that as practice and consistency of learning increases, attention load decreases (Shiffrin & Schneider, 1977). This premise suggests that as years of education and experience in nursing (e.g., practice) increase, the attention load required by a nurse to care for patients and subjective mental workload would decrease. Cardiovascular specialty experience because of its consistency with the care of cardiovascular patients in this study should be more closely related to subjective mental workload than general experience.

Definition of Terms

Education was defined as consistent and practiced learning acquired through a formal program of study leading to a degree or diploma in nursing. Education was measured by the total number of years of completed schooling (Nurse Demographics Data, Appendix A).

General Experience was defined as consistent and practiced learning that is acquired through the care of patients by a nurse after graduation from a basic school of nursing, and was measured as the number of years spent caring for patients (Nurse Demographics Data, Appendix A).

Basic School of Nursing was defined as the educational program preparing a nurse to first enter nursing practice, including: Associate Degree in Nursing (ADN), Baccalaureate of Science in Nursing (BSN), or a Diploma (Dip).

Specialty Experience was defined as consistent and practiced learning acquired through the care of critical cardiovascular patients by a nurse after graduation from a basic school of nursing, and measured by the number of years spent caring for this type of patient (Nurse Demographics Data, Appendix A).

Patient Care included the assessment, planning, intervention, and evaluation of patients by a nurse. Subjective mental workload was measured following the first four hours of patient care in a nurse's work shift which followed at least one, but not more than five days off.

Subjective Mental Workload was defined as a nurse's perception of attention load incurred while providing patient care that culminates from the mental, physical, temporal and environmental demands of care, and the effort, performance satisfaction, and emotionalism experienced in response to those patient care demands. Subjective mental workload was measured by the Nursing Task Load Index (Appendix H).

Mental Demand was the amount of information that needs to be cognitively processed by the nurse in order to provide care to an assigned patient or a group of patients. It was measured by the Mental Demand scale of the Nursing TLX.

Physical Demand was the amount of physical activity and energy required of a nurse when providing nursing care to

an assigned patient or a group of patients. It was measured by the Physical Demand scale of the Nursing TLX.

Temporal Demand was the time pressure experienced by a nurse due to rate or pace at which nursing care must be provided to an assigned patient or a group of patients. It was measured by the Temporal Demand scale of the Nursing TLX.

Environmental Demand was defined as the influence of the nursing unit's atmosphere and resources on a nurse's ability to provide patient care. It was measured by the Environmental Demand scale of the Nursing TLX.

Effort was the amount of mental and physical energy spent by a nurse in order to accomplish a given level of performance goals for an assigned patient or group of patients. It was measured by the Effort scale of the Nursing TLX.

Performance Satisfaction was the self-evaluation of nursing care goals set and achieved for an assigned patient or group of patients. It was measured by the Performance scale of the Nursing TLX.

Emotionalism was the range of positive and negative feelings experienced by a nurse while providing nursing care to patients. It was measured by the Emotionalism scale of the Nursing TLX.

Cardiovascular Critical Care was identified as a population of critical care nurses that responds to the needs of unstable, acutely ill patients with heart disease. In this

study, cardiovascular critical care included both Coronary Care Units (CCU) and Cardiovascular Intensive Care Units (CVICU).

Registered Nurses were defined as health care practitioners who hold an Associate or Baccalaureate degree in nursing or a Diploma in nursing, and who are licensed to practice nursing in the state where they are currently employed. Criteria for inclusion of the registered nurses in this research were: licensed to practice as a registered nurse, employed full- or part-time as a staff nurse to care for cardiovascular critical care patients, and voluntary participation.

Assumptions

1. Nurses have learned to care for patients through formal education programs and through work experience.
2. The amount of attention that is required to process information is reduced through practiced, consistent learning (Shriffrin & Schneider, 1977).
3. When similar information is repeatedly processed, attentional demands and subjective mental workload are reduced (Vidulich & Pandit, 1986).
4. Individuals have described their feeling of attention load in terms of subjective mental workload (Hart, 1986).

Limitations

1. Neither patient outcomes nor nurse performance were evaluated in this study.

2. Differences among nurses regarding their personal definitions and motivations to work were not addressed. For example, some nurses may enjoy working, whereas others may find it a necessary means of earning income.
3. Differences in clarity among workload tasks were not measured. For example, a simple bed bath varies depending on the size and condition of the patient.
4. The generalizability of this study's findings is limited to the targeted population.
5. Variations in the volume of assigned patients was not fully controlled in this study. The number of patients assigned to the subjects was small, given the critical care setting, but varied from one to three patients per nurse.
6. The mix of diagnoses among the patient care assignments of subjects was only partially controlled. Subjective mental workload was measured only when subjects were assigned to patients with diagnoses that were specified in the study.
7. Patient assignments to subjects were not manipulated in this study and may have been biased in relation to the education and experience levels of the nurses.
8. Years of education in disciplines other than nursing were not examined.

Summary

The National Commission on Nursing has called for the examination of nursing workload and for measures to reduce

that workload (Bowen, 1988). Emanating from a concern among nurses that traditional measures of nursing workload failed to capture the cognitive demands of patient care, subjective mental workload was suggested for study in nursing. Subjective mental workload measures have been used primarily among military populations. The content validity and reliability of the NASA TLX for nursing were examined to establish the suitability of this tool for nursing.

The General Theory of Human Information Processing was used to provide a theoretical framework for understanding subjective mental workload. It was suggested that variables that influence the use of attention may also influence subjective mental workload. Although subjective mental workload has not been studied in nursing, a positive association between experience and improved decision-making performance has been described in the literature. This research was proposed to examine the relationship among subjective mental workload, experience, and education.

CHAPTER II

Review of Research

A comparison of approaches and instruments used to measure mental workload are reviewed in the first section of this chapter. Justification for the selection of the NASA TLX for use in this research is discussed in relation to its validity and reliability among other work populations. In the second section, the origin studies of the GTHIP are described. Studies that have focused on learning background variables and information processing or subjective mental workload are reviewed. In the last section of this chapter, research that has examined other variables of subjective mental workload research are reviewed.

Measurement of Mental Workload

The cognitive construct of mental workload has been used to characterize the attention load incurred by a worker in response to work demands (Gopher & Donchin, 1986; Hart, 1986). The question of how best to assess attention load has led to four major measurement approaches: physiological, primary performance, secondary performance, and subjective (Gopher & Donchin, 1986; Lysaght, Hill, Dick, Plamondon, Linton, Wierwille, Zakland, Bittner & Wherry, 1989; Meshkati & Lowenthal, 1988; O'Donnell & Eggemier,

1986). Each measurement approach will be discussed in the following paragraphs. Rationale for the selection of a subjective measure of mental workload and the NASA TLX for this study is discussed.

Physiological Measures

Physiological measures have been used based on the assumption that changes in physiologic functioning occur when individuals are subjected to different levels of cognitive complexity in their work (Meshkati & Lowenthal, 1988). A large number of physiological parameters have been examined, including the central nervous system (electroencephalogram, evoked cortical potential), the autonomic nervous system (blood pressure, heart rate variability, pupil diameter), the endocrine system (body fluids), and the somatic system (muscle tension, eye movements) (Lysaght et al., 1989). Research findings have been mixed (Meshkati & Lowenthal, 1988; Lysaght et al., 1989). Heart rate variability, eyelid movements, and evoked cortical potential have been cited as the more promising parameters to explore (Gopher & Donchin, 1986). Physiological measures, due to their intrusiveness, have been limited to laboratory or simulated environments (O'Donnell & Eggemier, 1986).

Primary Performance Measures

Primary performance measures have been developed based on the assumption that changes in attention load result in behavioral changes that can be measured (Gopher & Donchin,

1986). Parameters that have been examined include reaction time, errors of omission, and errors of commission (Lysaght et al., 1989). The sensitivity of primary performance measures to changes in task difficulty has been criticized due to mixed research findings (Hancock & Meshkati, 1988). To use primary performance measures, a detailed task analysis and consensus within a field relative to performance standards are required (Lysaught et al., 1989).

Secondary Performance Measures

The use of secondary performance measures has been based on the assumption that attention load can be measured by challenging the fixed attention capacity of people and assessing performance changes (Gopher & Donchin, 1986). Secondary performance measures have included tasks, such as mathematical calculations or time estimation, that are administered to subjects while they are performing their primary work activities. Mental workload levels have been inferred from the decrement in reaction time and accuracy of either (or both) the primary or secondary tasks (Meshkati & Lowenthal, 1988). Secondary measures are considered to be time-limited; that is, they only measure the mental workload experienced by a subject while the secondary task is being imposed (Lysaght et al., 1989). Since secondary measures may interfere with the work performance of subjects, their use in some applied settings may be considered too intrusive or risky (O'Donnell & Eggemier, 1986).

Subjective Measures

Subjective measures of mental workload have been developed based on the assumption that subjects are aware of their attention load and can estimate variations in that attention load (Hart, 1986). How people feel, experience, and subjectively describe their mental workload is considered by some researchers as the only true measure of the construct (Johanssen, Moray, Pew, Rasmussen, Sanders & Wickens, 1979). Subjective measures have yielded a global assessment of mental workload, have been sensitive to changes in mental workload, have been deemed less intrusive than other mental workload measures, and have proven to be moderately diagnostic (Meshkati & Lowenthal, 1988; O'Donnell & Eggemier, 1986). Research findings have generally supported a positive relationship between subjective mental workload and task difficulty; that is, as task difficulty increased, subjective mental workload increased (Battiste & Hart, 1985; Hart & Staveland, 1988; Vidulich & Tsang, 1986).

The subjective measurement approach has been useful in applied settings where more intrusive measures were not feasible, in beginning studies where little was known about the mental workload of a population, and as a supplement with other measures of mental workload (Lysaght et al., 1989; O'Donnell & Eggemier, 1986). In this nursing research, a subjective measure of mental workload was

selected as the best means of understanding how nurse subjects experienced the mental workload of patient care.

Measurement of Subjective Mental Workload

Ideas have varied on how to capture the subjective experience of mental workload (O'Donnell & Eggemeier, 1986). Some researchers contended that subjective mental workload was unidimensional. The Modified Cooper-Harper (MCH) instrument reflected this position (Wierwille & Casali, 1983). It was focused on the single dimension of effort.

In contrast, three other subjective mental workload instruments were developed and based on the premise that subjective mental workload was a multidimensional construct. The Subjective Workload Assessment Technique (SWAT) was focused on effort, stress, and mental demand as subjective factors in mental workload (Reid, Shingledecker & Eggemeir, 1981). Use of the SWAT instrument required a mathematical weighting of the three test dimensions. The conjoint measurement technique required a special computer program to calculate the weights for each individual participant and was timeconsuming to score (O'Donnell & Eggemeir, 1986).

The bipolar scales, an early version of the NASA TLX, were composed of 10 factors: mental effort, physical effort, time pressure, task difficulty, frustration level, stress level, fatigue, activity type, performance satisfaction, and overall workload (Hart & Staveland, 1988). Validation studies conducted by Hart and Staveland (1988) led

to a reduction and reorganization of these 10 factors. The product of these validation studies was the NASA TLX, a six factor instrument that included mental demands, physical demands, temporal demands, effort, performance, and frustration. The NASA TLX was easy to administer and score, and required approximately 10 to 15 minutes to complete.

Validity and Reliability of the NASA TLX

The NASA TLX was the product of 10 years of research within the National Aeronautics Space Administration and among branches of the military (Hart & Staveland, 1988). The content validity of the NASA TLX as a measure of subjective mental workload was supported through expert opinion, surveys of broad populations, and factor and regression analyses (Hart & Staveland, 1988; Nygren, 1991). Construct validity of the NASA TLX was supported by experimental research conducted over time by multiple investigators. Most of this research focused on the performance of several subjective mental workload instruments in discriminating task difficulty, as well as correlations between the instruments (Byers, Bittner & Hill, 1989; Byers, Bittner, Hill, Zakland & Christ, 1988; Haworth, Bivens & Shively, 1986; Vidulich & Tsang, 1985a, 1985b, 1986). Concurrent validity was supported relative to the criterion of primary and secondary performance (Bortolussi, Kantowitz & Hart, 1985; Byers, Bittner, Hill, Zakland & Christ, 1988; Vidulich & Tsang, 1985a, 1986). No studies of predictive validity were found in the

literature. Internal consistency, test-retest, and parallel test forms reliability have been reported for the instrument (Hart & Staveland, 1988).

Content Validity. Research leading to the content validation of the NASA TLX was reported by Hart and Staveland (1988). Nineteen characteristics of subjective mental workload were generated by a team of NASA researchers, then rated in a survey of subjects from a wide range of occupations and educational levels (Hart & Staveland, 1988). Fourteen of the characteristics were retained using a content validity index (CVI) of 0.60. New groups of subjects were asked to evaluate their subjective mental workload using the 14 variables in a series of laboratory and flight simulation experiments (Hart & Staveland, 1988). The 14 factors were again reduced, resulting in nine specific and one overall workload test items. A subjective mental workload instrument, the bipolar scales, was developed using these 10 test items. The items included: mental effort, activity type, physical effort, time pressure, task difficulty, performance satisfaction, frustration level, stress level, fatigue, and overall workload (Hart & Staveland, 1988). A weighting step was added to the test procedure based on a belief by these researchers that some of the test items could be more important to some individuals than others.

Following the development of the bipolar scales, 16 additional experiments were conducted by a number of

researchers. The raw data from these experiments were collectively analyzed by Hart and Staveland (1988). The combination of data from the 16 experiments yielded a total of 247 subjects and 3,461 scores for each of the 10 test items. Subjects and work tasks were related primarily to the military. Work tasks performed among the experiments were clustered into five categories representing varying amounts of mental and physical demands. Correlation matrices and factor analyses for each of the work categories were reported. Factor loadings for the nine instrument scales were regressed onto the overall workload scale score, resulting in a total population regression coefficient of 0.73 (Hart & Staveland, 1988). The difference between the weighted and nonweighed scores was not significant.

Analysis of this grouped data resulted in further reduction of test items from 10 to 6. The test items in the revised NASA TLX were: mental demand, physical demand, temporal demand, performance satisfaction, level of frustration, and effort. A mean of the six new test items was used to indicate overall subjective mental workload. The weighting procedure was modified by having subjects compare current work relative to a standard reference task (Hart & Staveland, 1988).

Another series of experiments was conducted on the NASA TLX (Hart & Staveland, 1988). Six male subjects performed 13 different work tasks. These tasks were again grouped

into five similar work demand categories, ranging from single demand source (manual or cognitive) to multiple demand sources (combinations of manual and cognitive). A regression coefficient of 0.86 was obtained.

Construct validity. A number of studies have been conducted for the purpose of comparing different subjective mental workload instruments. The NASA TLX has been compared to the bipolar scales (Hart & Staveland, 1988), the Subjective Mental Workload Assessment Technique (Reid, Schingledecker & Eggemeir, 1981), the Modified Cooper-Harper (MCH) scale (Wierwille & Casali, 1983), and the Overall Workload scale (OW) (Vidulich & Tsang, 1987). These instruments have been developed by different researchers to measure the same construct, subjective mental workload. Each of the instruments has been shown to discriminate between different levels of task difficulty. Positive correlations then, between the NASA TLX and these other subjective mental workload instruments have provided support for construct validity.

A study of 24 college students and aircraft pilots was conducted using single, dual, and spatial transformation work tasks (task difficulty); the NASA bipolar scales were compared with SWAT. The results of this single study was reported across several publications. Vidulich and Tsang (1985a) reported that both instruments (bipolar and SWAT) performed comparably, although the standard deviation for SWAT (26.4) was greater than for the bipolar scales (17.1).

Vidulich and Tsang (1985b) reported a correlation of 0.78 ($p < 0.05$) between SWAT and the bipolar scales.

Similar findings have been reported by other researchers. Haworth, Bivens and Shively (1986) in a comparative study of flights with and without copilots, reported that the bipolar, SWAT, and MCH instruments successfully differentiated between the two levels of flight difficulty. The bipolar correlations with SWAT and MCH were 0.67 and 0.75 respectively; correlations were reported as significant. Nataupsky and Abbott (1987) compared the NASA TLX and SWAT ratings of four air force pilots on a computer generated flight simulation task. High and low levels of difficulty were created by the complexity of the simulated flights. Both the TLX and SWAT differentiated between the two flight difficulties ($p < 0.0001$).

Byers, Bittner, Hill, Zakland and Christ (1988) compared four instruments (NASA TLX, SWAT, MCH, and OW) in a ground control operation of a remotely piloted vehicle system. Four, four-man military crews each remotely flew five or more missions. The NASA TLX was most preferred by the participants and best described subjects perceptions of their mental workload (face validity). Principal component analysis revealed a single component which explained 75.2 percent of the total variance among the ratings of subjective mental workload. Mean factor loadings were consistently ordered ($p < 0.00005$): NASA TLX (0.910) >

SWAT (0.893) > OW (0.869) > MCH (0.833). Differences between the NASA TLX and SWAT were reported as significant, but no values were given.

Vidulich and Pandit (1987) examined individual differences between 22 pilots and 64 non-pilots, using a large battery of personality and behavioral measures and subjective mental workload (NASA TLX and SWAT). Personality differences between the two groups were reported, but no significant differences in subjective mental workload (both scales) were found. The researchers suggested that personality and subjective mental workload are two different mental constructs.

Concurrent validity. Bortolussi, Kantowitz and Hart (1985) examined relationships among three mental workload measurement approaches. In a study of twelve instrument-rated pilots, primary performance measures (reaction time), secondary performance measures (estimating clock time) and the bipolar scales were used to measure mental workload during a simulated flight. All three measures of mental workload differentiated between the easy and difficult flight simulations. This study supported the use of subjective methods as a means of measuring mental workload. Vidulich and Tsang (1985a, 1986) in their study of college students and pilots, found that both the bipolar scales and SWAT mirrored the performance ratings across three levels of task difficulty; that is, as errors and omissions increased, subjective mental workload increased. Hill,

Zakland, Bittner, Byers and Christ (1988) assessed the subjective mental workloads (NASA TLX) and primary performance of six enlisted soldiers on a mobile air defense system task. Stepwise regression analyses revealed that as performance decreased, subjective mental workload increased (r = 0.66, p < 0.0001); and conversely, as performance increased, subjective mental workload decreased.

Reliability. Correlation matrices of scores from the content validation studies were reported for both the bipolar scales and the NASA TLX (Hart & Staveland, 1988). As determined by Cronbach alpha, the internal consistency of the NASA TLX was 0.87 and 0.90 for the bipolar scales (Hart & Staveland, 1988). The loss in reliability represented a trade-off by the NASA researchers for a gain in the multiple regression coefficient (0.73 to 0.86).

The reliability of several parallel forms (pen/paper, computer, and verbal) were examined using three different tasks (target acquisition, grammatical reasoning, and unstable tracking). The correlations among the three parallel forms were high, ranging from 0.94 to 0.96 (Hart & Staveland, 1988). Using the same subjects (not described) and work tasks, the experiment was repeated two weeks later. The test-retest correlation between the two sets of ratings was 0.83 (Hart & Staveland, 1988). Battiste and Bortolussi (1988) in a study of 19 airline captains reported a NASA TLX test-retest correlation of 0.769 over an eight day period.

Byers, Bittner and Hill (1989) compared the NASA TLX (weighted) and the raw NASA TLX (not weighted). The two versions of the subjective mental workload instrument were compared using data from five studies of crew members in three different military operations. Weighted and raw means (41.27, 38.97) and standard deviations (22.43, 21.81) were comparable. The correlation between the raw TLX and the weighted TLX between pairs of the five studies ranged from 0.96 to 0.98; across studies, the correlation was 0.977 ($p < 10^{-6}$) (Byers, Bittner & Hill 1989). Using hypothetical data, Nygren (1991) confirmed these study findings and suggested elimination of the weighting procedure.

Validity for nursing. The conceptualization and measurement of subjective mental workload emanated from the work of human factors scientists among military and aviation populations. Subjective mental workload has not been considered unique to those populations. Studies of subjective mental workload have included college students and faculty, and more recently, physicians. These adult populations have included varying years of college education and work experience, and as such, were similar to the demographic characteristics of registered nurses in this study. Nurses have expressed the need to examine the mental demands of providing care to patients; this expressed need suggested that, like pilots and physicians, nurses have experienced mental workload.

While most of the early studies on subjective mental workload were conducted in controlled environments, the NASA TLX was used during actual aviation flights (Shively, Battiste, Matsumoto, Pepitone, Bortolussi & Hart, 1987). Subjects were videotaped during actual flights and subjective mental workload was measured subsequently at the time of viewing (Hill, Zakland, Bittner, Byers, & Christ, 1988). Physician mental workload was examined in ambulatory clinic settings using a modified version of the bipolar scales (Bertram, 1991). The extended use of the NASA TLX into actual work settings has provided support for its validity outside of controlled, simulated environments.

Learning, Information Processing and Subjective Mental Workload

The research reviewed in this section provided the foundation for this study of subjective mental workload in nursing. Broadly, the areas of research examined included the deductive origin studies for the General Theory of Human Information Processing (GTHIP), subjective mental workload research that examined the learning background of subjects, and information processing studies in nursing.

Deductive Origins of the General Theory of Human Information Processing

Ten controlled laboratory experiments that formed the deductive origins of their General Theory of Human Information Processing were reported in two separate publications by the theorists (Schneider & Shiffrin, 1977; Shiffrin & Schneider, 1977). In the first six experiments, divided

attention was examined; in the latter four, focused attention was studied. Across all of the studies, the cognitive tasks performed by subjects involved the search and detection of varying visual elements (digits, consonants) on a computer screen. Across experiments, the number of subjects was small (4 to 6) and a fairly equal number of males and females were used. Some subjects participated in more than one experiment.

In the first three studies, visual elements were presented to subjects using consistent and varied patterns of presentation (called mapping). It was hypothesized that as pattern consistency decreased, performance (accuracy and speed) would also decrease. Findings supported this negative relationship between varied mapping and performance. Performance was more affected by increased task demands under varied mapping conditions than under consistent mapping conditions.

The next three experiments were focused on learning and unlearning (Shiffrin and Schneider, 1977). The consistency of the task to be performed was varied at first, then changed to a consistent pattern. Accuracy improved from a base score of 50 percent correct under varied learning conditions to an ending score of 90 percent correct under consistent learning conditions; errors decrease from 12 to 3 percent. Unlearning (induced by a reversal of visual elements to be detected or ignored by subjects) precipitated a drop in the accuracy rate to well below the

original 50 percent base score. The two subsequent studies focused on categorical learning, or the development of information sets and cognitive patterns by subjects. Findings revealed that category learning developed under consistent mapping conditions and under some degree of varied mapping conditions, but not under full varied mapping conditions. As in the preceding study, unlearning induced mid-experiment caused a dramatic decrease in accuracy (80 percent to 20 percent). This set of three experiments supported consistency as a positive influence on the development of category learning.

The four remaining experiments were conducted for the purpose of examining focused attention. Results indicated that once subjects were able to focus their attention, the consistency or varied nature of the task had little impact on performance.

The GTHIP and Subjective Mental Workload

In a laboratory experiment using the General Theory of Human Information Processing, Vidulich and Pandit (1986) examined the relationships among training (practice), task consistency, and subjective mental workload. Nine male and seven female college students performed a series of computerized search and detection tasks. A main effect of memory set size and subjective mental workload was reported; as the amount of information that a subject had to remember increased, levels of subjective mental workload also increased. In a comparison of the memory set size effect

under consistent and varied task conditions, subjective mental workload was significantly higher for the varied condition than for the consistent one ($p < 0.005$). The researchers concluded that practice alone did not always reduce subjective mental workload. Reductions in subjective mental workload were realized to a greater degree when practice and consistency were combined.

Specialty Experience and Subjective Mental Workload

The study of subjective mental workload of physicians in two outpatient clinics was reported in two articles (Bertram, 1991; Bertram, Hershey, Opila & Quirin, 1990). Thirty-nine medical residents with one (15 residents), two (12 residents), and three (12 residents) years of experience were compared to nine experienced physicians already in private practice. No differences in subjective mental workload levels were reported within the resident group or between the residents and private practice physicians. Bertram noted that the level of physician experience was considered when patients were assigned, and this assignment consideration may have been a confounding variable. Physicians' experience with a particular patient health problem was negatively related to subjective mental workload ($p < 0.001$), providing some support for a relationship between experience and subjective mental workload.

Del Bueno (1990) reported a descriptive study of 563 nurses from among 10 hospitals. Each of the hospitals used the same type of computerized simulation system to measure

the clinical performance and skills of newly employed nurses. Details of the tests were not reported, and controls for internal validity appeared limited. Nurses with three or more months experience in their particular specialty area of practice were classified as experienced; nurses with fewer than three months specialty experience were classified as non-experienced, regardless of their total years of nursing experience. No significant differences in clinical judgment performance were found relative to years of specialty experience.

Monahan (1991) compared the clinical judgments of 16 baccalaureate students enrolled in a clinical nursing course. The class was randomly divided into two groups for this quasi-experimental study; one group was assigned the prescribed number of clinical hours, while the others received no clinical assignments. The researcher reported the use of the usual course test to measure differences in clinical judgment, but no further details of the tests are given. No differences in clinical judgment performance were found between the two nurse groups. Monahan questioned why clinical experience comprised such a large portion of the nursing curriculum. However, the validity and reliability of the test instrument were not reported.

Benner, Tanner and Chesla (1992) reported a qualitative, descriptive study of 105 baccalaureate nurses, drawn from eight hospitals and a mix of critical care units. Based on the earlier findings of Benner (1984), nurses were

clustered into three groups according to years of specialty (critical care) experience: Advanced Beginners (0 to 6 months), Intermediate-Proficient (2 years), and Expert (5 > years). Nurses were observed during patient interactions and asked to describe their clinical decisions regarding the patient. Findings supported a positive relationship between years of specialty experience and decision-making performance. Characteristic changes in the emotional responses of nurses to patient care demands were also reported. Advanced Beginners focused on the patient's current health status and the multiple tasks that needed to be performed to meet immediate needs. These nurses characteristically described patient care situations in terms of the demands placed on them. Intermediate nurses were characterized as being in a crisis stage; that is, they had begun to question the judgments of other colleagues. Their focus was on planning ahead; being prepared was very important for control and security. Proficient nurses demonstrated the beginnings of pattern recognition (categorical learning) and seemed less anxious about their patients and nursing decisions. Expert nurses managed rapidly changing patient situations with ease and were able to carry out their routine duties concurrently. In unfamiliar patient situations, expert nurses appeared to grasp the crux of the problem accurately and rapidly; experts also reported knowing circumstances in which situations were assessed correctly.

The findings of Benner, Tanner and Chesla (1992) supported a positive relationship between years of specialty experience and clinical decision-making. Evidence of a relationship between experience with a patient problem and subjective mental workload was reported in the Bertram (1991) research. No significant differences in years of specialty experience among physicians was reported; this finding may have been confounded by the patient assignment process.

General Experience and Subjective Mental Workload

Vidulich and Tsang (1985a) examined differences between pilots and non-pilots (experience versus no experience) using performance scores and subjective mental workload ratings as dependent variables. Twenty-four subjects participated, twelve college students and twelve certified aviation pilots. Computerized search and detection tasks similar to the inflight work tasks of pilots were used. Subjective mental workload levels for both groups mirrored changes in performance data; as error commission and omission increased, subjective mental workload increased. A main effect of experience was found but unexpectedly, it was the college student group that reported significantly lower mental workloads than the pilots ($p < 0.01$).

Considered a classic work in nursing, Benner's (1984) study of 67 nurses, drawn from three hospitals, revealed characteristic differences in the way nurses with varying years of general experience described the same clinical

incident. Twenty-one pairs of nurses (a new graduate and a nurse preceptor) were observed during a particular patient event and then interviewed. The content of these observations and interviews were analyzed within the framework of the Dreyfus and Dreyfus (1985) model of skill acquisition. Benner qualitatively described a positive relationship between years of general experience and clinical decision making skills. Nurses with more years of general experience perceived patient situations as a whole and intuited what needed to be done for the patient. Novices used rules to guide their actions.

Westfall, Tanner, Putzier and Padrick (1986) conducted an exploratory study of diagnostic reasoning among nurses using an information processing theory by Newell and Simon (1972). Subjects included 28 baccalaureate nursing students and 15 baccalaureate registered nurses; registered nurses had at least two years of general experience. Verbal protocols and videotaped, simulated patient situations were used. No significant differences in the number of accurate hypotheses, plausible hypotheses, implausible hypotheses, related hypotheses, or inferences for nursing actions were found. Further analyses revealed no significant differences between the two groups relative to the comprehensiveness, efficiency, proficiency, complexity, or the time used to formulate a diagnostic hypothesis. The researchers reported a trend in the mean scores which

suggested that the registered nurses were more efficient and proficient than the nursing students.

Itano (1989) compared the clinical judgment performance of 13 experienced registered nurses and 13 baccalaureate nursing students. Twenty-six actual hospital patients were used; interviews conducted by the nurses were videotaped and evaluated by a group of nursing faculty. Findings revealed that experienced nurses collected more cues than students, and used the cues differently in forming clinical judgments ($p < 0.01$). Significantly higher scores for the experienced nurses ($p < 0.01$) were awarded by faculty judges using a quantitative clinical judgment scale.

The findings of Vidulich and Pandit (1986) and of Vidulich and Tsang (1985a) appeared to be inconsistent with the premises of the GTHIP relative to benefits of task practice and consistency. In both studies, the onset of automatic processing among subjects may have been more rapid than anticipated by the researchers. Findings from two of the nursing studies suggested a positive relationship between information processing efficiency and years of experience increase (Benner, 1984; Itano, 1989). This relationship however was not supported in the Westfall, Tanner, Putzier and Padrick (1986) study. Further comparison of these studies was hindered by the lack of replication among them; none used the same subject population, the same measurement tools, or had subjects perform the same cognitive tasks as those in the other studies.

Education and Subjective Mental Workload

Hart and Staveland (1988) surveyed subjects from a wide range of occupations and educational backgrounds to determine factors of subjective mental workload. Although the demographics of the surveyed population were not published, the researchers reported finding no differences related to education or occupation. No research was located that examined the relationship between subjective mental workload and years of education among workers.

Information processing differences between nursing students and nurse graduates from three educational programs have been examined. Within nursing there are three education levels for practice entry. Nurses may enter practice following two (associate degree), three (diploma), or four (baccalaureate) years of education. In a review of literature on nursing information processing spanning from 1900 to 1982, Grier (1984) concluded:

> Education leads to differences in the process of making decisions and these differences appear to be positive. However, education does not increase [a nurse's] certainty about nursing data, nor lead to more effective strategies for making complex decisions. Decision making varies greatly among nurses, situations, and contexts (p. 281).

Linares (1989) compared the learning characteristics of two groups of baccalaureate nursing students. One hundred and seventy-five generic students (four continuous years of education) and 170 registered nurse student (Associate or diploma to baccalaureate) were compared using three measures of learning characteristics. No differences between

the two groups were found relative to locus of control, self-directed learning readiness, and learning preferences. Both groups showed a strong preference for learning that is tangible, specific and practical.

Haggarty (1990) compared the information processing strategies of female students enrolled in traditional and non-traditional academic majors. Traditional female majors included nursing and education; the non-traditional major was management. All subjects were seniors in their respective baccalaureate programs. Forty nurses (generic), 59 education majors, and 86 management students were sampled. The study was based on the Level of Processing Theory (Craik & Lockart, 1972) and used the corresponding instrument, the Inventory of Learning Processes. The theory and the instrument produced four categories of information processing: deep processing, methodological study, fact retention, and elaborative processing. No differences were found between nursing and education students on the learning processes. Significant differences were found between the traditional and non-traditional groups. Nursing and education majors tended to be syllabus bound learners (methodological study), and related information to be learned to practical applications (elaborative processing). Management majors, conversely, were conceptual, categorical thinkers (deep processing), and demonstrated a propensity for processing details (fact retention).

Geiger and Davidhizar (1990) examined differences between associate and baccalaureate degree nurses relative to their conceptual and theoretical approaches to patient care. An essay questionnaire was completed by 167 senior baccalaureate students and 176 senior associate nursing students. Findings revealed that four year baccalaureate students approached patient planning and care with long term goals in mind (process driven). In contrast, two-year associate students were more content driven, focusing on current patient events. Four-year baccalaureate students used nursing diagnoses, the nursing process, and evaluated the effects of nursing care interventions more so than two-year associate students. All reported differences in this study were statistically significant ($p < 0.05$). Young, Lehrer and White (1991) reported similar findings in a large descriptive survey of Illinois nurses in 1986; a response rate of 69 percent (69,792) was achieved. Baccalaureate nurses reported performing more patient assessments and formal care planning activities than their associate degree counterparts ($p < 0.01$).

Brooks and Shepherd (1990) examined the clinical decision making performance of 200 nursing seniors. Fifty students from each of the four types educational programs (associate, diploma, generic baccalaureate, and RN to baccalaureate) participated. No significant differences in clinical decision making performance were found among students of the educational programs. Sanford, Genrich and

Nowotny (1992) found no differences between 116 baccalaureate and non-baccalaureate (ADN, Diploma) nurses relative to clinical judgment performance.

With the exception of the Haggerty (1990) research, neither information processing theory nor nursing theory have been used to guide or interpret the findings of these studies. The time taken by subjects to form clinical judgments or clinical decisions could have provided additional insight into attention load differences, but was not examined. No research was located that examined the relationship between nursing education and information processing in an actual work setting. The findings of Linares (1989) and Haggarty (1990) suggested that baccalaureate nurses are homogeneous in their learning and information processing characteristics, and tend to be concrete, practical thinkers. No differences between years of nursing education and performance (clinical judgment and decision making) were found (Brooks & Shepard, 1990; Sanford, Genrich & Notwotny, 1992). However, there were differences in the information processing patterns used by nurses with varying years of nursing education (Geiger & Davidhizar, 1990; Young, Lehrer & White, 1991). How these research findings relate or if they relate to subjective mental workload is not clear.

Subjective Mental Workload, Specialty Experience, General Experience, and Education

No single study was located in the workload literature that examined the relationship among subjective mental

workload, experience and education. Very few studies explored individual characteristics related to subjective mental workload.

Work, Information Processing and Subjective Mental Workload

In this section, subjective mental workload research related to variables of work or the work environment are reviewed. Related information processing research from the nursing literature is included.

Automation

Automation as a work variable of subjective mental workload has been reported in the aeronautics literature. Using eight college students, the relationships between subjective mental workload and varying levels of automation were examined during three simulated flight segments (Liu and Wickens, 1987). Findings revealed that work tasks which competed for common processing sources (e.g., all visual or all manual) were time-shared less effectively and resulted in higher subjective mental workload ratings than tasks that competed for separate attention resources. Tsang and Johnson (1987) reported a small pilot study on work automation using six subjects on two manual and one decisional (semi-automated) tasks. Fully manual conditions received higher subjective mental workload ratings than semiautomatic conditions. Haworth, Bivens & Shively (1986) compared the subjective mental workloads of four helicopter pilots with and without a co-pilot in simulated combat missions. Automation of flight controls was varied for both

the pilot and co-pilot simulations. An average of 2.2 higher subjective mental workload ratings were reported for single pilot missions. Despite the available automated systems, peaks in subjective mental workload were found in flights with only one pilot that were not present to the same degree in flights with a pilot and a co-pilot.

Based on current measures of nursing workload, the National Commission on Nursing has recommended increased automation as a means of reducing the workload of nurses (Bowen, 1988). Research from the military community have suggested that the automation of work tasks may reduce or increase the subjective mental workload of workers.

In hospital nursing practice, nurses work on units along with other nurses. Sometimes two nurses are assigned to care for one patient because of the patient's high acuity level. Because two nurses are not always available for assignment to one patient, the development of automated systems has been recommended as an alternative. However, Haworth, Bivens and Shively (1986) demonstrated that the presence of a co-worker may be more effective in smoothing out peaks in subjective mental workload than automated systems.

Time and Volume

Johnson and Hart (1987) used six undergraduate students to perform a computerized tracking task. Time pressure (percentage of available time to capture a target) and total time (time taken to capture a target) were examined.

Significant positive correlations ($p < 0.05$) between both time variables and overall subjective mental workload were reported. Pepitone, Shively and Bortulussi (1987) examined the subjective mental workload of nine experienced pilots during the cruising and landing segments of three simulated flights. The duration (e.g., short, medium, long) of the segments were varied. The rate of work within a segment had more effect on subjective mental workload levels ($p < 0.014$) than did the duration of a work segment (not significant). Bertram, Hershey, Opila and Quirin (1990) studied 50 outpatient clinic physicians using a combined bipolar-SWAT subjective mental workload instrument. As the volume of patients seen by a physician per clinic session increased, subjective mental workload increased.

Comparisons of work segments have been used to diagnose peaks in work pace (work volume per time) within a larger work task. Shively, Battiste, Matsumoto, Pepitone, Bortolussi & Hart (1987) found that subjective mental workload peaked during the initial take-off segment of an actual flight and decreased over the duration of the mission. Only four subjects were used in this experiment however. Battiste and Bortolussi (1988), using 19 captains from major U.S. airlines, conducted a simulated transport flight experiment. Lower subjective mental workload ratings were recorded for the cruising segments than for either the take-off or landing segments.

Gaba and Lee (1990) measured the secondary performance (mathematical calculations) and subjective mental workload of 19 anesthesiology residents over 19 actual surgical patient cases. The subjective workload tool used in this study included the following test items: attention, complexity, time pressure, mental load, difficulty, and concentration. No support for the validity or reliability of the instrument was reported. A positive correlation ($p < 0.05$) was found between subjective mental workload and the number of tasks to be completed within a given time period. Surgical cases of long duration provided more maintenance segments (mental down times) than relatively shorter cases. Subjective mental workload was highest during the beginning induction and ending recovery segments.

Based on the research reviewed, it would appear that subjective mental workload is increased when time is limited and the volume of tasks is high. When smaller segments of a larger work task were compared, those segments with a higher concentration of tasks per unit of time resulted in higher subjective mental workloads. This positive relationship between work pace and subjective mental workload was demonstrated across laboratory and applied settings, including the health care field. In some of the reported research, there appeared to be a pattern of higher subjective mental workloads during the beginning and ending segments of a larger work task.

Work Roles

Byers, Bittner, Hill, Zakland and Christ (1988) examined subjective mental workload and the work roles of four, four-man crews during a ground control field test. Significant differences ($p < 0.05$) in subjective mental workload reflected the role variations of individual crew members. Team members whose roles involved planning and coordination of other workers reported higher subjective mental workloads than crew members whose role was to carry out the operations.

Diurnal variations

Hancock (1988), using a Latin-square design, randomly assigned 24 college students and staff to four groups. Subjective mental workload, auditory canal temperature (physiological measure), and primary performance on time estimation tasks were examined in relation to time of day (8am, 12pm, 4pm, 8pm) and gender. No significant differences in subjective mental workload were found between male and female subjects. A positive relationship between temperature and time of day, and a negative relationship between performance and time of day were reported. However, no significant relationship was found between subjective mental workload and time of day. Hancock suggested caution in generalizing these findings due to the small number of subjects in the experiment. Statistical findings in this study were not specified.

Summary

Most of the research on subjective mental workload was conducted in controlled, simulated environments and among military populations. Several recent studies of physician subjective mental workload conducted in actual patient care settings were reported (Bertram, 1991, Gaba & Lee, 1990). No studies of subjective mental workload of nurses were reported.

The content validity of the NASA TLX as a measure of subjective mental workload was supported through a series of surveys of workers. Test items with a Content Validity Index of 0.60 were retained (Hart & Staveland, 1988). The construct validity of the NASA TLX was supported by comparative studies of the instrument with other subjective mental workload instruments, including the bipolar scales (Hart & Staveland, 1988), SWAT (Reid, Schingledecker & Eggemeir, 1981), and the Modified Cooper-Harper scale (Wierwille & Casali, 1983). Concurrent validity of the NASA TLX was investigated and supported in comparative studies of the instrument with other measures of mental workload, including primary and secondary performance measures (Bortolussi, Kantowitz & Hart, 1985; Hill, Zakland, Bittner, Byers & Christ, 1988). Bertram, Hershey, Opila & Quirin (1990) introduced the use of the NASA TLX into health care settings, using a modified version of NASA TLX for physicians.

Research leading to the development of the GTHIP was reported. Findings revealed that practiced, consistent learning reduced attention demand in the performance of similar work tasks (Shiffrin & Schneider, 1977). Vidulich and Pandit (1986) reported no significant relationship between practiced, consistent learning and subjective mental workload. These researchers concluded that automaticity developed more rapidly than expected; the use of a more complex work task in an actual work setting was suggested for future studies.

Although subjective mental workload has not been studied in nursing, nursing experience and education have been studied in relation to how nurses process patient care information. Information processing studies in nursing were limited in number, rarely used a theoretical framework, and yielded mixed findings relative to education and experience.

Findings of positive relationships were reported respectively between subjective mental workload and automation, work pace, and work roles. A single study suggested that no relationships exists between time of day, gender, and subjective mental workload (Hancock, 1988). These findings among other work populations provided a basis for the methods used in this nursing study and for interpreting the findings.

CHAPTER III

Methodology

Design of the Study

A descriptive level correlational design was used in the principal study to examine subjective mental workload and its relation to specialty experience, general experience, and education. The content validity of the NASA TLX for use in nursing was assessed using a Delphi survey design (Lynn, 1986). A pilot study was conducted initially to assess the reliability of the NASA TLX for nursing, and to examine the adequacy of data collection procedures.

The study variables of experience, education, and subjective mental workload were examined as they naturally occurred; that is, they were not manipulated. Measurement of subjects in both the pilot and principal studies were obtained once for each subject. Full-time and part-time registered staff nurses identified from unit work schedules across the four hospitals were stratified into CCU and CVICU groups. An equal number of subjects were randomly selected for study from each group.

Setting of the Study

The settings for the pilot and principal research studies were four Cardiovascular Intensive Care Units and

four Coronary Care Units located among three medical centers in northeast Florida and one medical center in southeast Georgia. Nurses completed the research instruments in either the nursing unit or a break room.

The four medical centers, hereafter referred to as A, B, C, and D, were selected because of: (1) geographical proximity; (2) similar total bed size (A = 502, B = 468, C = 528, D = 493); (3) presence of both a coronary care unit (CCU) and a cardiovascular intensive care unit (CVICU); and, (4) accessibility to this researcher. The CCUs included in this study had a bed size range of 6 to 14 (A = 10, B = 10, C = 14, D = 6); the CVICUs had a bed size range of 6 to 10 (A = 10, B = 10, C = 8, D = 6).

Cardiovascular critical care units were selected because of the homogeneity of diagnoses among the patient population served; that is, acutely ill patients with cardiovascular disorders. Coronary care units served patients requiring medical nursing care; 40 to 50 percent of patients in the study units were admitted for circulatory disorders (Diagnostic Related Groups 121 through 124) or angioplasty (DRG 112), or both. Cardiovascular intensive care units served patients requiring surgical nursing care; 50 to 55 percent of patients in the study units were admitted for coronary artery by-pass surgery (DRGs 106 and 107).

Sample

The unit of analysis for this study was each registered nurse's set of responses to the Nursing TLX. Registered nurses were targeted due to the current supply and demand problems of this population that had been identified by the National Commission on Nursing (Bowen, 1988). Broadly, critical care nurses were selected because of the intensity of nursing care that they deliver (Dracup, 1987; Roberts, Minnick, Ginzberg & Curran, 1989), and their potentially high subjective mental workloads due to the pace of their work and the automation in their work environment.

Cardiovascular critical care nurses were selected as a means of reducing variations in subjective mental workload related to the work performed by nurse subjects. Across hospital settings, cardiovascular critical care nursing is fairly homogeneous. This homogeneity of nursing work emerges from the dominant diagnosis related patient groups (DRGs) in these units, and the standardization of cardiovascular nursing care procedures across hospitals afforded by these similar DRGs (Johanson, Wells, Hoffmeister & Dungca, 1988). The sample was stratified into CCU and CVICU nurse subjects, since there were differences in the dominant DRGs and the requisite nursing care between the units.

The Coronary Care Units included in this study employed approximately 87 registered nurses (A = 30, B = 20, C = 25, D = 12). The Cardiovascular Intensive Care Units employed

approximately 106 registered nurses (A = 30, B = 23, C = 31, D = 22). The total population of subjects potentially available for inclusion in this study was 193.

Inclusion criteria. Nurses who were employed to work in one of the eight cardiovascular critical care units from among the four medical centers were targeted for inclusion in this study. The inclusion criteria were:

(1) Licensed, either temporary or permanent, as a registered nurse in the state of employment;

(2) Employed full- or part-time as a staff nurse;

(3) Routinely assigned to care for adult cardiovascular critical care patients; and,

(4) Willing to participate.

Exclusion criteria. The exclusion criteria were:

(1) Nurses who were assigned management or educational responsibilities in addition to patient care; and,

(2) Nurses who were assigned joint responsibility for a patient(s).

Both of these exclusion criteria were intended to eliminate confounding influences on subjective mental workload due to work role differences.

Sample Size

Twenty subjects, an estimated 10 percent of nurses meeting the inclusion criteria, were selected for the pilot study. A sample size of 70 subjects (approximately 36 percent of the available population) was projected for the principal study using Cohen and Cohen's (1983) power

analysis for multiple correlation. The sample size of 70 subjects was based on a 0.05 alpha level of significance (Type I error), a power of 0.90 (Type II error, beta = 0.10), and an estimated effect size of 0.20. The levels used in this power analysis were based on recommendations for behavioral research (Chase & Tucker, 1976; Cohen & Cohen, 1983; McNemar, 1960; Polit & Hungler, 1987).

Sampling Method

Subjects for both the pilot and principal studies were selected using a stratified random sampling method; stratification was intended to assure equal representation of medical and surgical nurse groups. The pool of potential subjects meeting the inclusion criteria were stratified by their unit of employment, either CCU and CVICU; an equal number of subjects were drawn randomly from each strata. Subjects used in the pilot study were not included in the principal study to avoid testing bias due to repeated measurement.

To minimize variations in subjective mental workload due to the type of work performed by nurses within the CCU and CVICU strata, subjects were measured only on a day when they were assigned to patients with specific diagnoses. For CCU nurses, the diagnoses included potential or confirmed myocardial infarction and angioplasty; for CVICU nurses, the diagnoses of coronary artery bypass and angioplasty were used. Since these diagnoses represented the dominant DRGs within these units, the care of these types

of patients should not have been novel for the target population. Based on the GTHIP, novel diagnoses could confound the relationships among the study variables.

Nurses in the sample were measured at the end of the first four hours of a normally worked shift, following between one and five days off. During the first several hours of a work shift, nurses routinely assess the health status and needs of their assigned patients, and use this information to plan and organize care for that shift. This routine emanates from the Nursing Process (assessment, planning, implementing, evaluating) that is used by nurses to guide patient care activities. Activities that reflect this initial assessment/planning routine include shift report, review of patient records, patient rounds (seeing the assigned patients), and note taking. When this initial assessment/planning process ends is not easily discernable. Nurses commonly assess and plan while implementing care that has already been prescribed for their patients. The decision to measure at the end of the first four hours, instead of three or five hours, was an arbitrary one by this researcher.

The selection of the early work shift hours was based on the General Theory of Human Information Processing (Shriffrin & Schneider, 1977). The Nursing Process routine of assessment/planning theoretically would require that patient information be processed in relation to previously learned information held in the Long Term Store. Patient

care information processing was expected to be high during the early hours of a nurse's work shift. If relationships existed between and among subjective mental workload and the learning background variables, it was anticipated that these early hours of work would demonstrate those relationships.

Nurses provide care around the clock. Hancock (1988) reported no significant relationship between time of day (diurnal variations) and subjective mental workload. A preliminary survey of the study cardiovascular units has revealed that the majority of nurses worked either an eight-hour (morning, evening, night) or a twelve-hour shift (day, night). The distribution of nurses between these two shift durations was approximately even. Variations in subjective mental workload that might be due to shift duration were avoided by scheduling all measurements at the end of the first four hours of a work shift.

Instrumentation

Nurse Demographic Data

Specialty experience, general experience, and education were recorded on a Nurse Demographic Data form developed by this author (Appendix A). Specialty experience was measured as the number of years spent in cardiovascular critical care nursing since graduation from a basic school of nursing. General experience was measured as the total number of years spent caring for patients after graduation from their basic (entry into practice) school of nursing.

Education was measured as the total number of years spent in schools of nursing. All three of the learning background variables were measured as interval data (years). Basic demographic information was collected, including age, gender, race, employment status (full- or part-time), nursing degrees attained, shift normally worked, type of unit (CCU, CVICU) and employing hospital.

It was anticipated that the Nurse Demographics Data form would be used to generate a sampling frame for selecting study subjects. Nurses were asked to complete the form during meetings held to solicit subject participation in the research.

Work Demographics Data

A Work Demographics Data form (Appendix C) was used to record descriptive information specific to the day of testing (day of the week, time of day, volume of assigned patients, patient diagnoses). It was completed by this researcher on the test day for each subject.

NASA Task Load Index

Subjective mental workload was measured by the NASA Task Load Index (version 1.0) (Appendix B). Raw scores, rather than weighted scores were used. The use of raw scores has been recommended when broad segments of work are examined; weighted scores are recommended when specific work tasks are examined or when different work segments are compared (Hart, 1992). The correlation between the raw and weighted techniques was 0.98 (Byers, Bittner & Hill, 1989). This

high level of agreement between the two measurement techniques allowed for the use of the raw score method in this study without a detrimental loss in explanatory power.

The original NASA TLX has been published in a booklet that contains instructions for subjects, the rating scales and descriptions, and instructions to the researcher for administering the instrument and scoring the results (Human Performance Research Group, 1988). Minor modifications to the wording in subject instructions and scale descriptions for nursing were made initially by this researcher after consulting with Hart (1992). For example, instead of 'task', the nursing instructions referred to 'patient care'.

The NASA TLX consisted of six test items: mental demand, physical demand, temporal demand, performance, effort, and frustration level. Descriptions of each test item contained both positive and negative examples to avoid response bias. The descriptive statements for each test item were followed by a visual analogue scale with semantic extremes (high-low, good-poor). Ratings by subjects for each test item were made by placing an 'X' along the respective visual analogue scale. Each analogue scale was a twelve centimeter line divided into 20 equal segments, producing interval data. The instrument required approximately 10 minutes to complete.

Scoring of the NASA TLX was a two-part process. The 21 vertical ticks along each of the analogue scales

represented a range of 0 to 10 in increments of 0.5. If a nurse placed an 'X' between two ticks, the value of the right tick was used; that is, the rating was rounded up. A total workload score was calculated as a mean of the six test item ratings. Higher ratings on both the individual test items and the total workload score indicated higher subjective mental workloads.

Validity and Reliability of the NASA TLX

Content, construct, and concurrent validity for the NASA TLX have been supported among other populations and settings (Bortolussi, Kantowitz & Hart, 1985; Byers, Bittner & Hill, 1989; Byers, Bittner, Hill, Zakland & Christ, 1988; Hart & Staveland, 1988; Haworth, Bivens & Shively, 1986; Vidulich & Tsang, 1985a, 1985b, 1986). Internal consistency, parallel methods, and test-retest forms of reliability have also been demonstrated (Battiste & Bortolussi, 1988; Hart & Staveland, 1988). The content validity of the NASA TLX for use in nursing was examined in this first study of nursing subjective mental workload. Cronbach's alpha was used to measure the internal consistency of the modified instrument.

Protection of Human Rights

Subject participation in this study was voluntary and subjects were free to withdraw at any time. Participants in the delphi survey were advised of their human rights protection in an introductory letter (Appendix D). An informed consent was obtained from each participant in the

hospital studies (Appendix E). No compensation, monetary or otherwise, was awarded to subjects.

Under all circumstances, patient care took priority over the testing in the pilot and principal studies. No harmful effects to nurses or patients were anticipated.

Subject names were obtained initially for mailing and scheduling purposes; identification codes were used through the data collection stage. Subject names were obliterated on all forms once testing had been completed; a matched list of subject names and identification codes was kept in a locked cabinet by the researcher. All findings are reported in group form; no identifying characteristics of patients, nurses, units, or medical centers are given.

Consent to participate from nurse subjects was solicited by this researcher. Subjects were fully informed of the purpose of the study and their specific involvement. The NASA TLX instrument was reviewed, and the testing procedure was explained by this researcher.

Approvals for both the content validity survey and the principal studies were obtained from the University Institutional Review Board. An exempt review for the content validity survey and an expedited review for the principal study were requested (Appendix F). Additional approvals for the principal studies were obtained from each of the four medical center Investigation Review Boards.

Procedure for Data Collection

This research was conducted in three phases. The procedures for data collection are delineated for the instrument validation, pilot, and principal studies.

Validation of the NASA TLX

To examine the content validity of the NASA TLX for nursing, a procedure for pretesting the instrument prescribed by Lynn (1986) was followed. A network sample of twelve nursing experts was asked to participate in a Delphi survey. Nursing expert was defined for this pretest as a doctoral prepared registered nurse with a specialty practice in critical care. Each expert was asked to critique the six individual test items and the instrument in its entirety (Appendix D). A four point rating scale (1 = not relevant, 4 = very relevant) was used to quantify ratings by the experts; scores of three (3) or four (4) were considered as indicators of content validity (Lynn, 1986). A significance level of alpha 0.05 was used to accept or reject the content validity score. It was anticipated that the pretest of the instrument would be repeated if major revisions were suggested by the initial survey. The internal consistency of the NASA TLX was examined in the both the pilot and principal studies.

The names and employment locations of potential critical care nursing expert participants were generated using a network sampling technique. A nursing faculty member from a major southeastern university served as the initial

network source. To elicit participation by the nursing experts and to obtain mailing addresses, initial telephone contacts were made. The survey procedure was as follows:

1. A content validation packet (Appendix D) was mailed to each expert participant. A response date of two weeks from the projected receipt of the packet was set.
2. This researcher contacted each participant by telephone during the second interim week to assure receipt of the packet and to answer any questions.
3. Expert nurses' responses for each test item and the NASA TLX in its entirety were analyzed.
4. If major revisions to either a test item(s) or the instrument were indicated by the content validity index scores, the pretest procedure would be repeated using the same nurse experts.

Pilot and Principal Studies

This researcher contacted the critical care nursing directors in each of the study hospitals. The proposed research was explained, and meetings were scheduled with the nursing staff to solicit participants. Study procedures were as follows:

1. Upon meeting with nursing staff, this researcher explained the purpose, procedure, and instruments for the study. Nurses present at the meetings were asked to complete a Nurse Demographics form.

2. A sampling frame was generated from the completed Nurse Demographics forms. Nurses were stratified into two groups according to their practice base in CCU or CVICV.

3. Using chronological numbers beginning at one (01) and a letter indicating the practice base (CCU = A, CVICU = B), each nurse was assigned a number/letter code. Selecting a starting point on a table of random numbers and going down the list of numbers, this researcher selected subjects whose assigned number matched the random number. Each matched random number resulted in the selection of two subjects, one from CCU (A) and CVICU (B). A total of 100 names were drawn.

4. The first 20 nurses selected were designated for the pilot study. The next 70 subjects were designated for the principal study. An additional 10 subjects were used as replacement for subject mortality (e.g., resignations, withdrawal).

5. The pilot study was conducted following procedure step numbers six through nine. Pilot study data were analyzed to determine the internal consistency of the NASA TLX and the adequacy of data collection procedures. Adjustment of data collection procedures were made and reported.

6. A three week testing period for each hospital was arranged with the critical care nursing director, and with the nurse managers of the respective CCU and CVICU. Subjects from each hospital were notified by memo of their selection for inclusion in the study and the projected

three week testing period for their unit. Testing in the CCU and CVICU within a hospital was conducted concurrently.

7. The projected work schedule of subjects for the designated testing period was examined. A calendar of dates and shifts when each subject could be tested was projected based on their scheduled days off and shift assignment. Measurement times for the five work shift variations were: 11am (7-3, 7-7 shifts), 7pm (3-11 shift), 11pm (7-7 shift), 3am (11-7 shift).

8. On the day of testing for each subject, this researcher completed the Work Demographics Data form, and affirmed that the following criteria were met: (a) assigned to patients with inclusive diagnoses for the respective type of unit; (b) current work shift followed one to five days off; and, (c) work shift was the one normally worked by the subject.

9. Following the first four hours of patient care, subjects were instructed to complete the Nursing TLX. The test material was completed independently by the nurses subjects. Scored forms were collected by this researcher.

Data Analysis

All data were screened for accuracy prior to analyses. Descriptive statistics were reported for each phase of the research, including the instrument validation, pilot, and principal study phases. The validity and reliability of the NASA TLX for use in nursing was analyzed prior to the principal study. Instrument reliability was analyzed

again in the principal study. To answer the research questions posed in this study, data analyses were performed serially, at the conclusion of each of the study phases.

Data Screening

Study data were screened for missing data and outliers. Data that appeared in the ± 4 standard deviation range were treated as outliers. After assuring that the outliers were not due to incorrect data entry, deletion or transformation (e.g., inverse, logarithm, square) of the outliers were considered. Decisions for handling both missing data and outliers are reported. To determine if parametric statistics could be used, study data were examined for compliance with three assumptions: multivariate normality, linearity, and homoscedasticity. The Pearson Product-Moment Correlation Coefficients between education, general experience and specialty experience were examined for multicollinearity ($r > 0.90$).

Descriptive Statistics

The nurse demographics of all subjects and the work demographics for pilot and principal study subjects were examined using descriptive statistics. Both measures of central tendency (mean, mode, median) and dispersion (range, standard deviation, coefficient of variation) are reported. Subjects from the instrument validation, pilot, and principal studies are described separately.

Research Questions

A content validity index (CVI) was used to quantify the content validity of the NASA TLX for use among cardiovascular critical care registered nurses (question #1). The CVI was calculated as the proportion of experts awarding a score of three or four to each of the six test items and the NASA TLX instrument in its entirety. Agreement among the experts had to be significant at an alpha 0.05 for an item to be retained.

The reliability of the NASA TLX for use in nursing was examined using Cronbach alpha (question #2). The alpha coefficient is a measure of the internal consistency of an instrument, measuring the extent to which the rating on one test item is a good predictor of ratings on other test items (Waltz & Bausell, 1986). An alpha coefficient of 0.70 or greater was desired; a lower alpha coefficient would represent a limitation in this research. Alpha coefficients for both the pilot and principal study samples are reported.

The subjective mental workload among cardiovascular critical care registered nurses was examined and reported as the mean and standard deviation of the total NASA TLX scores across subjects (question #3). Means and standard deviations for individual test item scores are reported. The mean subjective mental workload scores of CCU and CVICU subjects were compared using a t test; significance was set at 0.05.

Bivariate correlational analyses were used to answer research questions four, five, and six. Relationships between subjective mental workload and each of the three learning background variables were calculated using the Pearson's Product Moment Correlation coefficient. The correlation coefficient (r) provided information about the direction (+ or -) and size of the bivariate relationships. A t test and alpha level of 0.05 were used to determine the significance of each bivariate relationships.

To answer the seventh research question, the relationships among the four study variables, multiple correlation analyses were conducted. The multiple coefficient of determination (R^2) was used to indicate the proportion of variance in subjective mental workload that was explained by specialty experience, general experience, and education. Multiple coefficients of determination (R^2) range from 0 to +1. The significance of the derived relationship was examined using an F statistic and an alpha of 0.05.

Post hoc Analysis

Bivariate correlations between specialty experience, general experience, and education respectively, and the six individual test item scores of the NASA TLX were examined using the Pearson Product-Moment Correlation Coefficient. Bivariate correlations between demographic variables (nurse and work) and mean total subjective mental workload scores were examined and reported. Nominal data were examined using a multiple comparison statistic, such as Least

Significant Difference (LSD) and the Student-Newman-Keuls test; in some cases, dummy variables were used to permit the use of a parametric test.

Summary

This research was conducted in three serial phases, including instrument validation, a pilot study, and a principal study. The content validity of the NASA TLX was examined by delphi survey of 10 to 12 nursing experts, and calculated as a content validity index. Cronbach alpha was calculated as a measure of the instrument's reliability in both the pilot and principal studies.

The unit of analysis of this descriptive survey, correlational design study was the registered nurse's set of responses to the Nursing TLX. A stratified random sample of 70 CCU and CVICU registered nurses were used for the principal study; full- and part-time staff nurses were included. Subjective mental workload was measured by the NASA TLX. Experience and education data were collected using the Nurse Demographics form. Subjective mental workload was measured at the end of a subject's first four hours of care to patients with inclusive diagnoses for the respective type of unit, on a normally worked shift, following one to five days off. The relationships between and among subjective mental workload and specialty experience, general experience, and education were analyzed using bivariate and multiple correlations.

CHAPTER IV

Findings

This research on nursing subjective mental workload was conducted in three phases: Instrument validation, pilot study, and principal study. Research questions were answered in the instrument validation and principal study phases. All statistical analyses reported in this chapter were calculated using SAS/PC statistical software (version 6.04).

Instrument Validation Study

The sample for the instrument validation study are described. Findings are used to answer the first research question in this study.

Sample

Twelve nursing experts were asked to participate in the instrument validation study; nine agreed to participate. Experts were defined in this study as nurses who specialized in critical care nursing and who had a doctorate degree in nursing. All nine participants were white females with a doctorate degree in nursing; the average age was 42 years. The mean critical care nursing experience among the nurse experts was 15.5 years, with a range of 10 to 27. Participants resided in one of eight states,

including, Connecticut, Florida, Georgia, Maryland, Mississippi, Ohio, and Texas.

Findings

What is the content validity of NASA TLX for registered nurses in cardiovascular critical care units (#1)? To answer this question, a two-stage delphi survey of nine critical care nursing experts was conducted. Surveys of the experts were spaced three weeks apart to minimize bias due to learning (Lynn, 1986). Content validity was determined using a Content Validity Index (CVI) and a significance level of $p < 0.05$. The distribution of ratings, the CVI for each test item, and the CVI for the instrument in its entirety are shown for the initial and second delphi surveys in Tables 1 and 2, respectively.

In the initial delphi survey, three of the six test items were given significant CVI scores ($p < 0.05$); the three response scales were not significant. Experts indicated having "difficulty seeing how the effort scale differed from the mental demand and physical demand" and suggested that there were only "subtle differences with [effort and] mental demand and physical demand". "Success in accomplishing nursing care goals" and "satisfaction with nursing performance" were considered to be two different concepts not measurable by the one Performance scale. Several experts gave low ratings to the Frustration scale because of the adjectives used to describe feelings;

Table 1

Summary of Content Validity Index (CVI) Scores of NASA TLX for Nursing: Initial Delphi Survey (N = 9)

		Rating Frequencies			
Test Item	CVI	1	2	3	4
Mental Demand	1.00*	-	-	6	3
Physical Demand	1.00*	-	-	5	4
Temporal Demand	.89*	-	1	1	7
Effort	.56	-	4	3	2
Performance	.78	-	2	2	5
Frustration	.78	-	2	3	4
Total Instrument	.89*	-	1	6	2

* $p < 0.05$

Table 2

Summary of Content Validity Index (CVI) Scores for Nursing TLX: Second Delphi Survey (N = 9)

		Rating Frequencies			
Test Item	CVI	1	2	3	4
Mental Demand	1.00*	-	-	1	8
Physical Demand	1.00*	-	-	1	8
Temporal Demand	.89*	-	1	2	6
Environmental Demand	1.00*	-	-	3	6
Effort	1.00*	-	-	2	7
Performance	1.00*	-	-	-	9
Emotionalism	.89*	-	1	-	8
Total Instrument	1.00*	-	-	1	8

* $p < 0.05$

insecure and complacent were not considered good descriptions of critical care nurses' emotional response to patients.

Suggestions for modifying the instrument were contributed by the experts in addition to the numerical ratings. The most common recommendations included modifications of the scale anchor words, elimination of two questions describing a single test item, and inclusion of more emotions.

One expert suggested the addition of a Personal Demand scale: "a personal crisis (disagreement with charge nurse, fight with spouse, sick child)." Similarly, another expert offered, "I would add emotionality or another domain that includes degree of emotional involvement in the tasks of critical care vs. detachment...interpersonal involvement. I think this is different from mental demands." Still another expert queried, "Add guilt? Doing things that prolong life when you know the patient wants to die."

The need to address the work environment demand was suggested. "Even if a critical care nurse's mental workload is low, if other nurses in the environment have a high mental workload (unstable patients, heavy assignments, etc.), the mental workload of the entire unit seems to increase...tension seems to travel." One expert asked about "working with incompetent people" and "not doing things someone wants you to do."

Based on the findings from the initial delphi survey, the NASA TLX was revised to include an Environmental Demand scale and an Emotionalism scale (in lieu of Frustration). The Effort scale was retained but reworded. A second delphi survey was conducted (Appendix G). The revised Nursing TLX was sent to the same nine nurse experts three weeks after the first survey was completed; all nine responded with ratings. The CVI for each of the seven individual scales and the Nursing TLX in its entirety were significant ($p < 0.05$). Minor changes were made based on expert suggestions from the second delphi survey. For instance, clarifying words and phrases in parentheses were positioned within the scale questions. The final version of the instrument was named Nursing TLX and used in the pilot study (Appendix H).

Pilot Study

The pilot study was conducted for two primary purposes. First, there was a need to determine the adequacy of the proposed study procedures. Second, there was a need to initially examine the internal consistency of the Nursing TLX.

Sample

Twenty nurse subjects participated in the pilot study. Eighty percent of the sample were Caucasian; 95 percent were female; the mean age of the group was 35.6 years. Subjects were graduates of three types of nursing academic programs: Associate (45 percent), Diploma (20 percent),

and Baccalaureate (35 percent). General nursing experience ranged from 2 to 23 years with a mean of 10.5 years. Cardiovascular nursing experience ranged from 1 to 18 years with a mean of 8.4 years. Subjects were equally distributed in number between coronary care units (10) and cardiovascular critical care units (10), and between eight (10) and twelve (10) hour shifts.

The number of subjects distributed across the four hospital settings (A = 5, B = 3, C = 8, D = 4) was unequal secondary to the random selection process. Wednesdays and Thursdays were the most frequent test days; test times ranged from 3:00AM to 11:00PM. All traditional eight (7-3, 3-11, 11-7) and twelve hour (7am-7pm, 7pm-7am) shifts were represented in the sample. The number of days off prior to the test date for a nurse subject was limited by the study design to a range of 1 to 5; the average number of days off for the pilot group was 2.5 days. The number of patients assigned to the nurses on the day of survey was small (1 to 3). The diagnoses of assigned patients were predominantly myocardial infarction (45 percent) and coronary artery bypass (40 percent).

Findings

Meetings to introduce the study and solicit nurse participants were poorly attended due to high patient census across nursing units. The resulting number of nurses who completed the Nurse Demographic Data forms was insufficient

to serve as a sampling frame for the study. As a result, study procedures were modified.

A sampling frame was generated from the nursing work schedules of each nursing unit rather than from the completed Nurses Demographic forms as originally planned. Subjects, randomly selected from the sampling frame, were notified in writing of their selection. A packet of information about the study was sent to subjects, rather than given out in unit meetings as originally planned (Appendix I). Included in the packet were: Notification letter; Nursing TLX and instructions for how to enter ratings; Nurse Demographic form; Work Demographic form; and, an Informed Consent form. Subjects were instructed not to complete the Nursing TLX and Work Demographic forms; these would be completed at a scheduled survey date and time. Questions by participants, if any, were answered at the time of the survey for each subject. All forms were collected by this researcher.

Cronbach's alpha for the Nursing TLX was 0.84. This level of internal consistency was well above the minimum range of 0.70 set for this study.

Principal Study

The demographic characteristics of the sample are described, data screening decisions are reported, and study findings are organized in response to research questions. Post hoc findings are also reported.

Sample

Eighty subjects, stratified by unit type (CCU, CVICU), were randomly selected for study; data were collected from 72 subjects. An unusually low census of coronary artery bypass patients in one study unit and the normal turnover of nursing personnel within units were the two most frequent reasons for subject loss (10 percent). Data screening resulted in the deletion of two subjects as outliers. Data from 70 nurse subjects were included in the study.

The nurse demographics are described in Tables 3 and 4. The 70 subjects were predominantly Caucasian females (77 percent) ranging in age from 22 to 49 years. The four-year baccalaureate degree was the highest academic preparation in nursing among subjects. The mean years of general nursing experience was 11.5, with a range of 1 to 30 years. Years of cardiovascular nursing experience averaged 7.6 with a range of 1 to 21 years. When the sample was stratified by unit type, there were no significant difference between the CCU and CVICU nurses related to years of specialty experience (t = - 0.179, df = 68, p = 0.85), general experience (t = 0.667, df = 68, p = 0.51), and education (t = 0.127, df = 68, p = 0.89).

Work demographics were divided into three groups: Work Environment (Table 5), Work Schedule (Table 6), and Work Assignment (Table 7). All of the nurses were employed by one of the four study hospitals. There were no nurses from

Table 3

Summary Means and Percentage (%) Distributions of Nurse Demographic Variables (N = 70)

Variable	Distribution n	%
Age		
20 - 29 years	13	18.6
30 - 39 years	34	48.6
40 - 49 years	23	32.8
Gender		
Male	3	4.3
Female	67	95.7
Race		
Black	5	7.1
Caucasian	55	78.6
Other	10	14.3
Nursing Program		
Associate	27	38.6
Diploma	9	12.9
Baccalaureate	34	48.6

Table 4

Summary Distribution Measures for Years of Experience and Education (N = 70)

Item	Mean	SD	Range	Median	Mode	CV
			Experience			
General	11.5	6.2	1 - 30	12.0	14.0	54.4
Specialty	7.6	5.2	1 - 21	7.0	1.0	69.4
			Education			
Total	3.1	0.9	2 - 4	4.0	3.0	30.1

Table 5

Summary Means and Percentage (%) Distributions of Work Environment Demographic Variables (N = 70)

Variable	Distribution n	%
Hospital		
A	20	28.6
B	14	20.0
C	20	28.6
D	16	22.9
Type of Hospital		
Teaching	30	42.9
Non-Teaching	40	57.1
Unit		
CCU	35	50.0
CVICU	35	50.0
Day of Week		
Monday	21	30.0
Tuesday	7	10.0
Wednesday	13	18.6
Thursday	9	12.9
Friday	8	11.4
Saturday	12	17.1

Table 6

Summary Means and Percentage (%) Distributions of Work Schedule Demographic Variables (N = 70)

Variable	Distribution n	%
Employment Status		
Full-Time	42	60.0
Part-Time	28	40.0
Shift Length		
Eight Hours	25	35.7
Twelve Hours	45	64.3
Shift		
7a - 7p	23	32.9
7p - 7a	19	27.1
7a - 3p	10	14.3
3p - 11p	7	10.0
11p - 7a	6	8.6
Other	5	7.1

Table 7

Summary Means and Percentage (%) Distributions of Work Assignment Demographic Variables (N = 70)

Variable	Distribution n	%
Prior Days Off		
One	18	25.7
Two	22	31.4
Three	14	20.0
Four	4	5.7
Five	12	17.0
Volume of Patients		
One	20	28.5
Two	48	68.6
Three	2	2.9
Patient Diagnoses		
MI	21	30.0
Angioplasty	4	5.7
CABG	32	45.7
MI and Angioplasty	10	14.3
MI and CABG	3	4.3

staffing agencies since the sampling frame was drawn from projected unit work schedules; agency nurses are usually obtained on the day that they are needed. Subjects were equally distributed between CCU and CVICU. Most of the subjects worked full-time (42 percent) on a twelve hour work shift (45 percent). Subjects were unevenly distributed across six different work shifts. The times of data collection ranged from 3 AM to 11 PM, varying according to the time a nurse started a work shift. Nurses were administered the Nursing TLX following at least one day off, but not more than five days off. During the first four hour of work, subjects were most frequently assigned to care for two patients (68.6 percent), and to patients with diagnoses of Myocardial Infarction (30 percent) or Coronary Artery Bypass (45.7 percent).

Data Screening

Data were examined for accuracy of entries and missing values. Age entries were missing in four cases, or five percent of the selected subjects. Queries were sent to the individual subjects and the missing data were obtained. Prior to analysis, education, general experience, specialty experience, mean mental workload (MMW), and the seven mental workload scales (mental, physical, temporal, environmental demands, and effort, performance, and emotionalism) were examined for conformity with parametric assumptions. Two cases on the performance scale were found to be outliers. Visual examination of the two outlier cases

suggested that subjects may have erred in marking the scale; the high/low direction of scale anchors for the performance test item are the reverse of the other scales. Deletion of the two outliers reduced the kurtosis of the performance variable from 3.7 to 0.7 and the skewness from 1.7 to 0.9.

The residual and predicted values for the variables were plotted; the scatter plot suggested homoscedasticity. The plot of residuals against the ranks indicated that the residuals were normally distributed. There was no indication of multicollinearity among the three independent variables. Correlation between general experience and specialty experience was the highest among pairs (r = 0.51, p = .0001).

Findings by Research Question

The remaining six research questions are answered in this section. Subjective mental workload and its relation to experience and education are addressed.

What is the reliability of NASA TLX for Nursing for registered nurses in cardiovascular critical care units (#2)? Internal consistency of the Nursing TLX using Cronbach's Alpha was 0.82 using both raw and standardized variables. Alpha coefficients for the seven scales of Nursing TLX ranged from 0.76 to 0.82 (Table 8). Inter-item correlation coefficients were significant (p <0.05) for 18 of the 21 scale pairs (86 percent); inter-item correlation coefficients ranged from 0.24 to 0.72.

Table 8

Summary Cronbach Alpha and Inter-item Correlations of Nursing TLX (N = 70)

		Inter-item Correlation (r)						
Item[a]	Alpha	MD	PD	TD	ED	EF	PF	EM
MD	0.81	1.00						
PD	0.79	0.32	1.00					
TD	0.76	0.63	0.47	1.00				
ED	0.82	0.14*	0.18*	0.34	1.00			
EF	0.76	0.54	0.62	0.79	0.27	1.00		
PF	0.81	0.08*	0.28	0.24	0.34	0.26	1.00	
EM	0.78	0.27	0.36	0.47	0.34	0.43	0.72	1.00

[a] MD, Mental Demand; PD, Physical Demand; TD, Temporal Demand; ED, Environmental Demand; EF, Effort; PF, Performance; EM, Emotionalism.

* Correlations were not significant for $p < 0.05$.

What is the subjective mental workload of registered nurses in cardiovascular critical care units (#3)? Univariate analyses of subjective mental workload total and scales scores are reported in Table 9. The mean mental workload of cardiovascular critical care nurses across hospitals was 4.3. Means for the seven scales for all subjects ranged from 2.1 (Performance) to 6.2 (Mental Demand). Additionally, mean subjective mental workload levels are reported by nurse demographic variables (Table 10), work environment variables (Table 11), work schedule variables (Table 12), and by work assignment variables (Table 13).

Nurse subjects were stratified into two groups according to unit type, either CCU or CVICU. The overall mean mental workload of CVICU nurses was 4.5 (SD = 1.3) compared to a mean of 4.2 (SD = 1.5) among CCU nurses. Differences between the two were not statistically significant (t = - 1.01, df = 68, p = 0.32). Analysis of Variance (ANOVA) indicated that mean mental workload scores among the four hospitals (A = 4.9, B = 4.4, C = 4.2, D = 4.1) were not statistically different (F = 1.10, df = 3, 66, p = 0.3561).

What is the relationship between subjective mental workload and the specialty experience of registered nurses in cardiovascular critical care units (#4)? The Pearson Correlation Coefficient was used to examine the relationship between subjective mental workload and specialty experience. Findings were not significant (r = - 0.11, p = 0.3671). Relationships between specialty experience and each of the seven scales of Nursing TLX were examined using

Table 9

Summary Distribution Measures for Subjective Mental Workload (N = 70)

Item	Mean	SD	Range	Median	Mode	CV
Total Score	4.3	1.3	1.1-7.4	4.6	5.5	31.9
Scales						
Mental	6.2	2.1	1.5-9.5	6.5	7.5	34.5
Physical	5.1	2.2	0.5-9.5	5.5	5.5	43.9
Temporal	5.0	2.3	0.5-9.5	5.0	5.5	45.4
Environmental	3.5	2.1	0.5-7.5	3.2	1.5	60.7
Effort	5.2	1.8	0.5-8.5	5.5	4.5	35.3
Performance	2.1	1.3	0.5-6.5	1.5	1.5	63.8
Emotionalism	3.0	1.9	0.5-8.5	2.5	1.5	62.4

Table 10

Summary Mean Subjective Mental Workload By Nurse Demographic Variables (N = 70)

Variable	n	Mean
Age		
20 - 29 years	13	4.03
30 - 39 years	34	4.35
40 - 49 years	23	4.55
Gender		
Male	3	4.80
Female	67	4.34
Race		
Black	5	3.64
Caucasian	55	4.37
Other	10	4.64
Nursing Program		
Associate	27	4.64
Diploma	9	4.47
Baccalaureate	34	4.20

Table 11

Summary Mean Subjective Mental Workload by Work Environment Demographic Variables (N = 70)

Variable	n	Mean
Hospital		
A	20	4.23
B	14	4.93
C	20	4.09
D	16	4.36
Type of Hospital		
Teaching	30	4.63
Non-Teaching	40	4.16
Unit		
CCU	35	4.19
CVICU	35	4.53
Day of Week		
Monday	21	4.14
Tuesday	7	4.78
Wednesday	13	4.63
Thursday	9	4.24
Friday	8	3.95
Saturday	12	4.56

Table 12

Summary Mean Subjective Mental Workload By Work Schedule Demographic Variables (N = 70)

Variable	n	Mean
Employment Status		
Full-Time	42	4.39
Part-Time	28	4.31
Shift Length		
Eight Hours	25	4.22
Twelve Hours	45	4.44
Shift		
7a - 7p	23	4.00
7p - 7a	19	4.74
7a - 3p	10	4.69
3p - 11p	7	3.88
11p - 7a	6	4.23
Other	5	4.70

Table 13

Summary Mean Subjective Mental Workload By Work Assignment Demographic Variables (N = 70)

Variable	n	Mean
Prior Days Off		
One	18	4.26
Two	22	4.03
Three	14	4.39
Four	4	3.27
Five	12	5.43
Volume of Patients		
One	20	3.88
Two	48	4.49
Three	2	6.05
Patient Diagnoses		
MI	21	4.72
Angioplasty	4	4.97
CABG	32	4.31
MI and Angioplasty	10	3.28
MI and CABG	3	5.13

Pearson Correlation Coefficient. No significant relationships were documented ($p < 0.05$).

What is the relationship between subjective mental workload and the general experience of registered nurses in cardiovascular critical care units (#5)? The Pearson Correlation Coefficient was used to examine the relationship between subjective mental workload and general experience. Findings were not statistically significant ($r = 0.03$, $p = 0.7956$). Pearson Correlation Coefficients between general experience and each of the seven scales of the Nursing TLX were not statistically significant ($p < 0.05$).

What is the relationship between subjective mental workload and the education of registered nurses in cardiovascular critical care units (#6)? The Pearson Correlation Coefficient was used to examine the relationship between subjective mental workload and education. Findings were not significant ($r = -0.09$, $p = 0.4344$). Pearson Correlation Coefficients between education and the respective scales were not significant ($p < 0.05$).

What is the relationship among subjective mental workload, specialty experience, general experience, and education of registered nurses in cardiovascular critical care units (#7)? Multiple regression was conducted by regressing the independent variables (specialty experience, general experience, education) onto the dependent variable (mean subjective mental workload). Only four percent ($R^2 = 0.04$) of the variance in subjective mental workload was explained by education, general and specialty experience. The relationship among the variables was not statistically significant ($F = 0.812$, $df = 3, 66$, $p = 0.4919$).

Relationships among specialty experience, general experience, education and individual scales were not significant ($p < 0.05$).

Post hoc Analyses

This research was the first reported study of subjective mental workload for nursing. Post hoc analyses were conducted as a means of expanding this data base for nursing subjective mental workload. Bivariate analyses of mean subjective mental workload and the demographic variables were conducted. The Pearson Correlation Coefficient was used to examine interval data. Multiple comparison tests, including Student-Newman-Kuels (SNK) and Least Significant Difference (LSD), and Analysis of Variance (ANOVA) were used to examine nominal data. Stratified groups of subjects were compared using t tests.

Subjective mental workload was not significantly correlated with the age ($r = 0.11$, $p = 0.3709$) or gender ($r = -0.07$, $p = 0.5827$) of the subjects, nor was it influenced by diurnal variation ($r = 0.14$, $p = 0.2461$). There were no significant differences in subjective mental workload when subjects were stratified by teaching and non-teaching hospitals ($t = -1.39$, $df = 68$, $p = 0.1668$), full- and part-time employment ($t = 0.24$, $df = 68$, $p = 0.8139$), or eight and twelve hour shifts ($t = -0.62$, $df = 68$, $p = 0.5386$). Multicomparison by hospital ($F = 1.10$, $df = 3,66$, $p = 0.3561$), work shift ($F = 0.92$, $df = 5, 64$, $p = 0.4720$), and day of the week ($F = 0.51$, $df = 5, 64$, $p = 0.7674$)

revealed no significant differences in mean subjective mental workloads.

The Pearson Correlation coefficient between subjective mental workload and volume of assigned patients was significant (r = 0.26, p = 0.0250). Multiple comparison tests revealed that nurses who were assigned to care for three patients had higher subjective mental workloads than nurses assigned to only one patient, but the difference was not statistically significant (F = 3.01, df = 2, 67, p = 0.0561).

The Pearson Correlation coefficient between subjective mental workload and the number of days off prior to the survey was 0.23 (p = 0.0460). Multiple comparison revealed that nurses who had been off five days prior to the survey, versus one to four days, experienced significantly higher mean subjective mental workloads (F = 3.02, df = 4, 65, p = 0.0241).

The relationship between subjective mental workload and five patient diagnosis groups was compared: myocardial infarction (MI), angioplasty, coronary artery bypass (CABG), MI and angioplasty, and MI and CABG. Higher mean subjective mental workloads were found for nurses assigned to an MI-CABG patient mix than for the other diagnostic groups (F = 2.49, df = 4, 65, p = 0.0519). A potential interaction effect between patient volume and patient diagnoses was investigated using a general linear model; the interaction effect was not significant (F = 1.28,

df = 4, p = 0.2895). Diagnosis remained significant (F = 2.71, df = 4, 64, p = 0.0099) when volume was accounted for in the regression model. Multiple regression was conducted by regressing patient volume, patient diagnoses, and number of days off onto subjective mental workload. These three variables accounted for 21 percent (R^2 = 0.21) of the variance in subjective mental workload (F = 3.32, df = 69, p = 0.009).

Summary of Findings

1. The Nursing TLX was adapted from the original NASA TLX instrument for the purpose of measuring subjective mental workload among cardiovascular critical care nurses. In addition to the original mental, physical, temporal demand scales, an environmental demand scale was included in the nursing version of the instrument. Two of the original response scales, effort and performance, were retained in the nursing version of the instrument; however, an emotionalism scale replaced the former frustration scale. Nursing experts rated the Nursing TLX valid (CVI = 1.00, p < 0.05) in its entirety. The CVIs for the seven scales ranged from 0.89 to 1.00; all CVI scores were significant (p < 0.05) for the final version of the instrument.

2. Internal consistency for Nursing TLX was 0.82. Cronbach alpha scores for individual scales ranged from 0.76 to 0.82. Inter-item correlations were significant (p < 0.05) for 18 of the 21 scale pairs. Two scale pairs, temporal

demand-effort (r = 0.79, p = 0.0001) and performance-emotionalism (r = 0.72, p = 0.0001), had the highest inter-item correlation scores.

3. The subjective mental workload for the 70 cardiovascular registered nurses ranged from a low of 1.1 to a high of 7.4, with a group mean of 4.3. Total group scores for the seven instrument scales ranged from a low of 2.1 (Performance) to a high of 6.2 (Mental Demand). Coronary care nurses experienced a lower mean mental workload (4.19) than CVICU nurses (4.53), but the difference was not statistically significant (t = - 1.0115, df = 68, p = 0.3154).

4. Specialty experience among the nurses ranged from 1 to 21 years, with an average of 7.6 years. The relationship between subjective mental workload and specialty experience was not significant (r = - 0.11, p = .3671).

5. General experience among the nurses ranged from 1 to 30, with an average of 11.5 years. The relationship between subjective mental workload and general experience was not significant (r = 0.03, p = 0.7956).

6. Nursing education among the nurses ranged from two to four years. The relationship between subjective mental workload and years of nursing education was not significant (r = - 0.09, p = 0.4344). The mean subjective mental workload was lowest among nurses holding a four-year Baccalaureate degree (4.20) and highest among nurses prepared in three-year Diploma programs(4.64); two-year Associate

degree nurses experienced an average subjective mental workload of 4.47.

7. Specialty experience, general experience, and education accounted for only four percent (R^2 = 0.04) of the variance in subjective mental workload, and this relationship was not significant (F = 0.812, df = 3, 66, p = 0.4919).

8. Subjective mental workload was significantly related to the volume (r = 0.26, p = .0250) of patients, diagnoses of assigned patients (F = 2.49, df = 4, 65, p = 0.0519), and number of days off prior to survey (r = 0.23, p = 0.0460).

CHAPTER V

Discussion, Conclusions, Implications, and Recommendations

The discussion of study findings is organized around the seven research questions; post hoc findings are addressed. Conclusions are drawn and summarized from the discussion. Implications for nursing are discussed and recommendations for future research are offered.

Discussion

What is the content validity of the NASA TLX for registered nurses in cardiovascular critical care units?

Findings from the instrument validation surveys supported the content validity of NASA TLX in its entirety for use among critical care nurses. Suggestions for modification of the three response scales (effort, performance, frustration) and the need to address the work environment led to revision of the instrument. The new nursing version of the instrument was named Nursing TLX.

Several of the nursing experts who were surveyed suggested that effort was essentially the same as demand. This conceptual position was not new. Wierwille and Casali (1983) asserted that subjective mental workload was unidimensional and contended that effort was the singular dimension of the mental workload concept. Hart and Staveland

(1988) combined demand and effort in the original version of the NASA TLX and created two scales labeled Mental Effort and Physical Effort. The description of what would become the effort scale in the revised NASA TLX instrument was labeled Task Difficulty in the original version. Bertram (1991) used mental and physical effort rather than demand in the NASA TLX modified to measure physician mental workload. The conceptual argument that demand and effort are the same seems to be based on the assumption that if demand is present, effort will be commensurate with that demand. Counter to this assumption is a premise of Expectancy Theory (Vroom, 1964). According to this theory, the amount of effort exerted by individuals in the performance of a task depends on their assessment of the energy required and the payoff for expending that energy. Critical care nurses may titrate their efforts across patient care demands depending on the payoff and risks to the patient. The Effort scale in this study was thus retained and its wording refined.

Experts suggested that work environment was important in the subjective mental workload of critical care nurses. Environment was not addressed in the NASA TLX (Hart & Staveland, 1988). Bertram (1991) included a difficulty scale which addressed the adequacy and availability of helpers for the physician, but other environmental factors (traffic, noise) were not included. In hospitals, nurses not only provide direct care to patients but also

coordinate services rendered by others (i.e., physical therapy, laboratory). Nurses care for patients continuously over 8 and 12 hour periods in one work environment. These characteristics of hospital nursing practice support the need to include environment as an element of nursing subjective mental workload.

A tenet of the nursing profession is caring. Perhaps because of this caring relationship, the nurse experts recommended that the range of emotional responses to work demands be expanded. The emotions component of subjective mental workload in other instruments has been addressed using the concept of stress. In the Subjective Workload Assessment Technique (SWAT) survey tool developed by Reid, Shingledecker and Eggemeir (1981), stress is the only emotion-related scale. Bertram (1991) identified psychological stress as the emotional component of physician mental workload. In the original version of the NASA TLX (Hart & Staveland, 1988), a stress scale was included in addition to a frustration scale. These findings appear to support the recommendation in this study for the expansion of the emotional component. The label emotionalism was selected for the revised scale at the suggestion of one of the nurse experts. Wording for the scale was refined to address feelings that may be experienced by nurses while caring for patients.

This first study of subjective mental workload focused on validating the content of the NASA TLX for use among

critical care nurses. The NASA TLX however, has been examined for other forms of validity in addition to content (Byers, Bittner, Hill, Zakland & Christ, 1988; Hart & Staveland, 1988; Haworth, Bivens & Shively, 1986; Vidulich & Tsang, 1985a, 1985b). Adaptation of other subjective mental workload instruments (e.g., SWAT) for nursing may provide a useful means of further validating the Nursing TLX. Bertram, Hershey, Opila and Quirin (1990) used volume of assigned patients to examine the validity of the tool modified for physicians. In both the physician study and this nursing research, volume of patients was significantly correlated with subjective mental workload. These similar findings provide additional support for the validity of both versions of the TLX instrument.

What is the reliability of the NASA TLX for registered nurses in cardiovascular critical care units?

The Nursing TLX was internally consistent based on a Cronbach alpha of 0.82. This level of internal consistency was slightly less than the findings of Hart and Staveland (1988) for the original NASA TLX (0.87), but approximate to Bertram's (1991) instrument adapted for physicians (0.80 to 0.83).

Mental workload is a cognitive construct that has been used to characterize the attention load incurred by a worker in response to work demands (Gopher, 1986; Hart, 1986). Since the NASA TLX (and the Nursing TLX) consisted of both work demand scales and responses to those demands, it would seem logical that inter-item correlations would be

present. Indeed, the finding of significant inter-item correlations in this study followed a pattern seen in the NASA TLX instrument literature of other work populations (Bertram, Hershey, Opila & Quirin, 1990; Nygren, 1991). This redundancy among scales limits the analytical capacity of the instrument by reducing the degrees of freedom for error. The highest inter-item correlations in the Nursing TLX were between Temporal Demand and Effort (r = 0.79, p = 0.0001), and between Performance and Emotionalism (r = 0.72, p = 0.0001). Examined in light of the above mental workload definition, the interrelationship between Temporal Demand and Effort is considered logical. The relationship between Performance and Emotionalism, two response scales, suggested the need to further refine the wording of the scales.

What is the subjective mental workload of registered nurses in cardiovascular critical care units?

The mean and range of subjective mental workload found in the nursing study are similar to the range and means of other work populations. Registered nurses in this study experienced an average subjective mental workload of 4.3 with a range of 1.1 to 7.4 at the end of their first four hours on duty. Bertram, Hershey, Opila and Quirin (1990) examined the mental workload of physicians in an outpatient setting and found a mean experience of 4.4 at the end of a half-day clinic session; mean scores ranged from 1.4 to 6.9. Byers, Bittner and Hill (1989) summarized findings from five flight simulation studies of military pilots

(N = 677); the mean subjective mental workload across studies was 41.27, ranging from 31.23 to 52.25 (on a scale of 0 to 100 versus 0 to 10).

The highest mean score on any one scale was 6.2 for Mental Demand. Nurses rated the mental demands of patient care higher than physical, temporal, or environmental demands. Of the three response scales, the mean score for Effort was highest (5.2). These findings appeared to reflect the intense cognitive components of caring for critically ill patients.

The cognitive requirements of patient care however, may not have been fully challenged in this study. By study design, subjects were tested only when they were assigned to care for patients with diagnoses common to that unit; that is, the diagnoses of assigned patients were familiar to the nurses. According to the GTHIP, as familiarity with a task increases through practice and task consistency, attention load (and mental workload) decreases (Shiffrin & Schneider, 1977).

Failure to find significant differences related to a number of individual nurses and work variables among the nurses in this study may be explained by parallel findings in the literature. Research has suggested that nurses are homogeneous in the way that they learn, or cognitively process, information. Linares (1989) found that nurses showed a strong preference for learning that is tangible, specific, and practical. Similarly, Haggarty (1990) found

that nurses tended to be syllabus bound learners (methodological processing) and related information to be learned to practical applications (elaborative processing). In the latter study, the information processing profile of nurses was significantly different from the profile of managers. In the present study, nurse managers were excluded to control for role differences, but may provide a comparative group for future study.

What is the relationship between subjective mental workload and the specialty experience of registered nurses in cardiovascular critical care units?

According to the GTHIP, consistent practice on a task reduces attention demands and leads to improved performance; improved performance is the result of a change from controlled to automatic mode of information processing (Shiffrin & Schneider, 1977). The finding in this study of no significant relationship between specialty experience and subjective mental workload may indicate that nurses were able to automatically process much of their patient information. This may be particularly true since the assigned patients had diagnoses which were routine for the units and thus familiar to the subjects. Vidulich and Pandit (1986) found that the onset of automaticity was rapid even in a controlled laboratory study.

Benner, Tanner and Chesla (1992) described differences in decisionmaking among three groups of nurses; nurses with greater than five years of specialty experience were classified as experts, those with two years as

Intermediate-Proficient, and those with 0 to 6 months as Advanced Beginners. In the present study, all of the subjects had at least one year of specialty experience, and the cognitive task (e.g., four hours of patient care) was much broader than the discrete decisionmaking task in Benner's study. These differences in experience range and cognitive task may explain the findings in this study.

What is the relationship between subjective mental workload and the general experience of registered nurses in cardiovascular critical care units?

The essentially zero correlation coefficient found in this study suggested an independent relationship between general experience and subjective mental workload. Although the GTHIP would suggest that specialty experience would have a stronger correlation with mental workload than general experience, due to the degree of consistency, the finding of an independent relationship is puzzling. Research within nursing (Itano, 1989) and among military pilots (Vidulich & Tsang, 1985a) have suggested that a larger quantity of information may be processed by individuals with a broad base of experience than those with no experience. If this were true, it would be reasonable that attention load and subjective mental workload would be positively related to general experience years. This however, was not the case in the present research.

What is the relationship between subjective mental workload and the education of registered nurses in cardiovascular critical care units?

At the onset of this research, it was unclear as to how education might relate to subjective mental workload. To the degree that years of nursing education represent consistent practice, the GTHIP would suggest a positive correlation with subjective mental workload. No studies of education as a variable of subjective mental workload were reported in the literature. Findings from related nursing studies however, suggested that four-year baccalaureate nurses cognitively processed information differently than two-year associate degree nurses (Geiger & Davidhizar, 1990; Young, Lehrer & White, 1991). Findings from the present study reflected those differences as well, although the relationship was not significant.

What is the relationship among the subjective mental workload, specialty experience, general experience, and education of registered nurses in cardiovascular care units?

Within the clinical practice of nursing, a positive relationship between past learning (specialty and general experience) and improved decisionmaking performance among nurses has been described (Benner, 1984; Benner, Tanner, and Chesla, 1992). Differences in information processing between four-year baccalaureate and two-year associate nurse graduates have been described (Geiger & Davidhizar, 1990; Young, Lehrer & White, 1991). Bertram (1991) however did not find evidence of a relationship between years of experience and the subjective mental workload of clinic

physicians. These related study findings appear to support the low and insignificant relationship found in this research.

The lack of significant relationships between experience and mental workload found in this study of nurses and Bertram's (1991) study of physicians may have been due to the specificity of the cognitive task performed by subjects. In both the physician and nursing studies, practitioners were asked to rate a patient care segment of about four hours in duration. Variations in the cognitive demands over those work segments were only minimally controlled (i.e., type of patients and setting). Alternatively, failure to find a relationship between education and experience in both this research and Bertram's (1991) physician study could have been confounded by the provider-patient assignment process. In clinical practice, the provider's education and experience are generally considered when assignments to patients are made.

Failure to find a significant relationship may have been related to the broadly defined task (e.g., four hours of patient care) used in this study. Alternatively, the Nursing TLX may be insensitive to gross differences among subjects such as years of education or experience. Using a more discrete cognitive task (e.g., assessment of a patient) or more defined learning variable (e.g., caring for the same patients over successive assignments) may

provide a more accurate understanding of the relationship between subjective mental workload and past learning.

Post hoc findings

As a first study of subjective mental workload in nursing, relationships between subjective mental workload and the respective nurse and work demographic variables were examined. Although variations in mean scores were found, no significant relationships between mental workload and nurse characteristics, work environment, or work schedule variables were evidenced.

Hancock (1988) reported no relationships between subjective mental workload, time of day or gender. Bertram, Hershey, Opila and Quirin (1990) found no significant associations between physician mental workload and age, race, or gender. Early conceptualizations of subjective mental workload have suggested the importance of individual differences in subjective mental workload (Hart & Staveland, 1988), but research to date has not been supportive.

Subjective mental workload was significantly related to the volume of patients cared for (r = 0.26, p = 0.0250) and to the diagnoses of assigned patients (F = 2.49, df = 4, 65, p = 0.0519). While Bertram, Hershey, Opila and Quirin (1990) did not examine patient diagnoses as a variable in physician mental workload, findings from that research did support patient volume as an important variable (r = 0.29, p = 0.05). Volume of work within a fixed time period

(e.g., rate or pace of work) also has been reported as a significant variable of subjective mental workload among other work populations (Gaba & Lee, 1990; Johnson & Hart, 1987; Pepitone, Shively & Bortulussi, 1987). Volume of assigned patients and nursing procedures (associated with patient diagnoses) have been variables in the traditional measures of nursing workload. It would appear then that at least two variables, patient volume and diagnoses, may share common ground between traditional nursing workload and subjective mental workload measures.

An unexpected finding in this research was the positive association between subjective mental workload and the number of days that a nurse had been off prior to the time of survey ($r = 0.23$, $p = 0.0460$). Multiple comparison revealed that only when the number of days off reached five was the difference in subjective mental workload significant. If days off are considered a respite from work, then why would nurses with the longest rest periods experience the highest mental workloads? One possible explanation may be that as the number of days off increase, nurses are more likely to be assigned all new patients. Increased time off may also create a need to catch up an new policies and memorandums in addition to caring for assigned patients.

A review of the literature revealed no studies that examined rest as a workload variable. However, fatigue was examined as a variable in subjective mental workload. Bertram, Hershey, Opila and Quirin (1990) found that

physicians who were fatigued or tired most of the day scored high mental workloads (tau-b = - 0.24, p = 0.02). Further investigation of this variable is warranted.

Conclusions

1. The subjective mental workload of cardiovascular critical care nurses included: mental demands, physical demands, temporal demands, environmental demands, effort, performance, and emotionalism. The Nursing TLX, an instrument that measures these components, is valid for at least one population of nurses.
2. The Nursing TLX was demonstrated to be internally consistent.
3. Cardiovascular critical care nurses in this study reported a moderate level of subjective mental workload when caring for patients with routine diagnoses.
4. Specialty experience and subjective mental workload were not significantly related in this study of cardiovascular critical care nurses.
5. General experience and subjective mental workload were not significantly related in this study of cardiovascular critical care nurses.
6. Education and subjective mental workload were not significantly related in this study of cardiovascular critical care nurses.
7. There was no significant relationship among subjective mental workload, experience, and education in this study of cardiovascular critical care nurses.

8. Three work assignment variables were significantly related to subjective mental workload, including the number of patients cared for, the diagnoses of assigned patients, and the number of days that a nurse had been off.

Implications For Nursing

This research was conceived in response to a contention among nurses in hospitals that current measures of nursing workload failed to account for the cognitive demands of patient care. An instrument to measure one cognitive aspect of patient care, subjective mental workload, was introduced in this study. The validity and reliability parameters of the Nursing TLX supported its usefulness for future nursing studies. A beginning data base of information about the subjective mental workload of nurses was generated by this research. Researchers may use these reported findings as a starting point for future study, and as a foundation for comparative data.

Findings of no significant relationships between or among subjective mental workload, experience and education were inconsistent with cognitive patterns among nurses in other studies. Some support for the General Theory of Human Information Processing was suggested by the negative direction of the relationships between subjective mental workload and education and specialty experience, respectively. There is a need to explore further the ways that nurses learn (from each other, repetitive patient assignments) and how those forms of past learning influence their

mental workloads while caring for patients. The relationship between past learning and present mental workload has implications for how nurses are oriented to new units and how nurse-patient assignments are made.

Post hoc findings were conceptually interesting. Two variables, patient volume and diagnoses, that have been influential in current measures of nursing workload were found to be related to the subjective mental workload of critical care nurses as well. These findings appear to suggest that current measures of nursing workload may address the cognitive demands of patient care more than originally expected. The need to expand current conceptual thinking on nursing workload however, was supported by another finding. A positive relationship was found between subjective mental workload and the number of days off between work periods. Although the source of this mental workload variable (e.g., fatigue, rest, new patient assignments) could not be determined by this study data, the finding supports the need for further theory development relative to nursing workload.

A major implication of this research has been the recognition by this nursing administrator for further workload theory development. Findings from this study have supported the existence of the subjective mental workload construct among one group of nurses, as well as the presence of common ground between current workload and subjective mental workload measures. Expanded conceptual

thinking of nursing workload may lead to improved administrative systems for nurses and better nursing care for patients.

Recommendations

Based on the findings of the study, recommendations for further research are offered. Recommendations include:

1. The validity of Nursing TLX in this study was confined to one group of critical care nurses. To expand the usefulness of the instrument within nursing, content validity among other nurse specialty populations should be examined. Other forms of validity should also be examined.
2. The internal consistency of Nursing TLX in this study was confined to one group of critical care nurses. To expand the usefulness of the instrument within nursing, internal consistency should be examined in other nurse specialty populations.
3. To provide comparative data for the findings in this study, subjective mental workload should be examined among similar nursing populations. To expand the data base of nursing subjective mental workload, other nursing populations and clinical settings should be studied.
4. Comparative studies of nurses with little or no specialty experience and those with specialty experience are warranted. Subjects in this study had a minimum of one year experience.
5. Studies of nurses with different levels of academic preparation should to be conducted using performance on a

specific cognitive task as a point of comparison. For example, conducting an initial assessment of a patient.

6. The nurse-patient assignment process warrants further investigation. To what extent are education and experience considered in nurse-patient assignments? When events preclude consideration of these two variables, what happens to subjective mental workload?

7. The positive correlation between subjective mental workload and number of days off suggested that future research might address rest, fatigue, and new patient assignments as potential variables of subjective mental workload. Nursing work schedules should be examined in relation to subjective mental workload, such as the Baylor weekend schedule or the seven days on-seven days off patterns.

8. Research is called for that compares subjective mental workload measures and traditional measures of nursing workload. Understanding variables that influence both forms of measurement may contribute to the development of a theory of nursing workload.

Summary

The discussion of the findings from this first study of nursing subjective mental workload have been focused on: the validity and reliability of the Nursing TLX, the subjective mental workload of cardiovascular critical care nurses, and relationships among education, experience, and subjective mental workload. It was concluded that while

the content validity and reliability of Nursing TLX was supported, further instrument development studies are warranted. The Nursing TLX appeared to be insensitive to differences among broadly defined variables, such as nurse demographics (e.g., gender, race) and work variables (e.g., diurnal variations).

Significant relationships found post hoc between subjective mental workload and work assignment variables (e.g., volume of patients, diagnoses of patients, number of days off) were discussed. It was concluded that traditional measures of nursing workload may share common ground with subjective mental workload measures. Further study is warranted.

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APPENDICES

Appendix A

Nurse Demographic Data

NAME: _____

HOSPITAL: _____

AGE: _____ years GENDER: ( )male ( )female

RACE: ( )Caucasian ( )Black ( )Hispanic ( )Other_____

UNIT: ( ) CCU ( ) CVICU, or Open Heart Recovery

1. WHAT SHIFT(S) DO YOU NORMALLY WORK AT THE PRESENT TIME?

   ( )7-3 ( )3-11 ( )11-7 ( )7a-7p ( )7p-7a

   Other (specify) _____

2. HOW MANY HOURS, ON THE AVERAGE, DO YOU CURRENTLY WORK EACH WEEK?

   ( )8hrs ( )16hrs ( )24hrs ( )32hrs ( )40hrs

3. WHAT NURSING DEGREES HAVE YOU ATTAINED?
   [Please mark all that apply]

   ( )ADN ( )DIPLOMA ( )BSN ( )MSN ( )Doctorate

4. AFTER GRADUATION FROM YOUR BASIC NURSING SCHOOL:

   A. APPROXIMATELY HOW MANY YEARS HAVE SPENT IN AN ACTIVE PRACTICE OF NURSING? _____

   B. ON THE AVERAGE, HAVE YOU WORKED FULL OR PART-TIME DURING YOUR ACTIVE PRACTICE YEARS (CHECK ONE)?

      ( )FULL TIME ( )PART-TIME

   C. APPROXIMATELY HOW MANY YEARS HAVE YOU SPENT IN CARDIOVASCULAR NURSING? _____

   D. ON THE AVERAGE, HAVE YOU WORKED FULL- OR PART-TIME DURING YOUR CARDIOVASCULAR PRACTICE YEARS (CHECK ONE)?

      ( )FULL-TIME ( )PART-TIME

Appendix B

NASA Task Load Index (Version 1.0)
(Human Performance Research Group, 1988)

Mental Demand

How much mental and perceptual activity, or attention, was required to care for your patients (e.g. thinking, deciding, calculating, remembering, watching, monitoring)? Were the patient care requirements easy or demanding, simple or complex, exacting or forgiving?

Low _____ High

Physical Demand

How much physical activity was required to care for your assigned patients (e.g. pushing, pulling, turning, controlling, activating, etc.)? Were the physical care requirements easy or demanding, light or strenuous, restful or laborious?

Low _____ High

Temporal Demand

How much time pressure did you feel due to the rate or pace at which your patients required nursing care? Was the pace of your work slow and leisurely or rapid and frantic?

Low _____ High

Effort

How hard did you have to work (mentally and physically) to accomplish your level of performance, given your performance goals?

Low _____ High

Performance

How successful do you think you were in accomplishing the nursing care goals set by someone else or yourself? How satisfied are you with your performance in accomplishing those goals?

Poor _____ Good

Frustration Level

How insecure, discouraged, irritated, stressed and annoyed versus secure, gratified, content, relaxed and complacent did you feel while working?

Low _____ High

Appendix C

Work Demographic Data

1. HOSPITAL: ( ) A ( ) B ( ) C ( ) D

2. NURSING UNIT: ( )CCU ( )CVICU

3. DAY OF THE WEEK: ( )M ( )T ( )W ( )TH ( )F ( )S ( )SN

4. PRESENT WORK SHIFT:

( )7-3 ( )3-11 ( )11-7

( )7a-7p ( )7p-7a ( )Other_____

5. NORMAL WORK SHIFT?

( ) YES ( ) NO

6. NUMBER OF CONSECUTIVE DAYS OFF-DUTY PRIOR TO THIS SHIFT:

( )1 ( )2 ( )3 ( )4 ( )5

7. NUMBER OF PATIENTS ASSIGNED:

( )1 ( )2 ( )3 ( )4

8. DIAGNOSES OF ASSIGNED PATIENT(S):

( ) Myocardial Infarction

( ) Angioplasty

( ) Coronary Artery By-pass

RESEARCHER NOTES

_____

_____

Appendix D

Content Validity Survey I

Subject Letter

Thank you for agreeing to participate in my study. The purpose of the study is to examine the content validity of a subjective mental workload instrument, the NASA TLX (National Aeronautics Space Administration Task Load Index), for use among critical care nurses. Content, construct, and concurrent validity of the NASA TLX have been reported in the literature of other populations, including military aircraft pilots, college personnel and students. The subjective mental workload of nurses however, has not been examined.

This content validity study is part of a dissertation that will focus on the subjective mental workload of critical care nurses. You are being asked to participate in this pre-test of the instrument because of your level of education and experience in critical care nursing; that is, you have expert knowledge of what it is like to provide nursing care to critically ill patients in a hospital setting.

An overview of subjective mental workload is given as background information on the construct that you are being asked to consider. In Part I, you are asked to evaluate the content validity of each the six test items that comprise the NASA TLX. In Part II, you are asked to

evaluate the entire instrument for content validity. A brief demographics questionnaire is also included.

Opinions rendered by experts in this study will be kept confidential and anonymity will be maintained. The critiques will be reviewed only by this researcher and my dissertation committee. Your response forms are already coded with an identification number; names matched with the code numbers will be kept in a locked cabinet by this researcher. Data from this survey will be reported in group form, so that no individual may be identified.

Your opinion of the NASA TLX is invaluable and will facilitate the future study of the subjective mental workload of nurses. No compensation, monetary or otherwise, will be given for your participation.

If you have any questions regarding what you are being asked to do, please feel free to contact me at work or at home. Please complete and return your ratings to me by _____. Again, I appreciate the time that you have contributed to this research endeavor.

Introductory Information

In the most general sense I want to measure the workload that critical care nurses experience when they are caring for patients. It is important to point out that I am not talking about measuring nursing workload in the traditional way that we think of workload; that is, using a patient classification or acuity system. These traditional systems measure the time that is required by nurses to care for

different categories of patients, not how a nurse experiences the work of patient care.

How work is experienced by individuals is thought to be primarily a mental process, involving the amount of attention that is needed to perform the work at hand. Information processing theorists contend that attention is required to mentally process work information. In humans, however, the amount of attention that is available to process information is fixed; that is, people can only think about so many things at one time. Given the large amount of complex information from patients, monitors, and other providers that critical care nurses must mentally process in order to provide patient care, understanding their subjective mental workload is important. The instrument you are being asked to evaluate is intended to measure the subjective mental workload that a nurse experiences when performing the work of caring for critically ill patients.

Researchers have found that people commonly describe their subjective mental workload in terms of the mental, physical and time demands of work, and their responses to those demands, including effort, performance satisfaction, and frustration (Hart and Staveland, 1988). Instruments that have been developed by different researchers to measure subjective mental workload include variations of these factors.

PART I
TEST ITEM EVALUATION

The NASA TLX is comprised of six test items: mental demand, physical demand, temporal demand, effort, performance, and frustration level. Descriptions of each of the test items contain both positive and negative examples. The descriptive statements for each test item are followed by a visual analogue scale with semantic extremes (high-low, good-poor).

Directions

A nursing definition for each test item is given, followed by the NASA TLX scale for that test item. Please rate each test item according to the extent that you believe it is a relevant component of subjective mental workload among critical care nurses. A rating of 4 indicates that you believe that a test item is very relevant and succinct. A rating of 1 indicates that you believe that a test item is not relevant.

Under the Comments section, suggestions for the addition/deletion of words or phases to the test item may be made, if in your opinion, such changes would make a test item more meaningful for critical care nurses. If you believe that a test item is not relevant (1), please indicate your rationale for suggesting its deletion.

ID CODE # _____

MENTAL DEMAND

Nursing Definition

Mental Demand is the amount of patient care information that needs to be cognitively processed by a nurse in order to provide care to an assigned patient or group of patients.

NASA TLX: Mental Demand

How much mental and perceptual activity was required to care for your patients (e.g. thinking, deciding, watching, calculating, remembering, monitoring)? Were the patient care requirements easy or demanding, simple or complex, exacting or forgiving?

Low_____**High**

Content Validity Rating

Please **circle** the number that applies to this test item.

1 = not relevant
2 = unable to assess relevance without item revision
3 = relevant, but needs minor alterations
4 = very relevant and succinct

Comments

_____

_____

_____

_____

ID CODE # _____

PHYSICAL DEMAND

Nursing Definition

Physical Demand is the amount of physical activity that is required of a nurse when providing nursing care to an assigned patient or group of patients.

NASA TLX: Physical Demand

How much physical activity was required to care for your assigned patients (e.g. pushing, pulling, turning, controlling, activating, etc.)? Were the physical care requirements easy or demanding, light or strenuous, restful or laborious?

Low _____ **High**

Content Validity Rating

Please **circle** the number that applies to this test item.

1 = not relevant
2 = unable to assess relevance without item revision
3 = relevant, but needs minor alterations
4 = very relevant and succinct

Comments

_____

_____

_____

_____

ID CODE # _____

TEMPORAL DEMAND

Nursing Definition

Temporal Demand is the time pressure experienced by a nurse due to the rate or pace at which nursing care must be provided to an assigned patient or group of patients.

NASA TLX: Temporal Demand

How much time pressure did you feel due to the rate or pace at which your patients required nursing care? Was the pace of your work slow and leisurely or rapid and frantic?

Low _____ **High**

Content Validity Rating

Please **circle** the number that applies to this test item.

1 = not relevant
2 = unable to assess relevance without item revision
3 = relevant, but needs minor alterations
4 = very relevant and succinct

Comments

_____

_____

_____

_____

ID CODE # _____

EFFORT

Nursing Definition

Effort is the amount of physical and mental energy spent by a nurse in order to accomplish a given level of performance goals for an assigned patient or group of patients.

NASA TLX: Effort

How hard did you have to work (mentally and physically) to accomplish your level of performance, given your performance goals?

Low _____ **High**

Content Validity Rating

Please **circle** the number that applies to this test item.

1 = not relevant
2 = unable to assess relevance without item revision
3 = relevant, but needs minor alterations
4 = very relevant and succinct

Comments

_____

_____

_____

_____

ID CODE # _____

PERFORMANCE

Nursing Definition

Performance is the self-evaluation of nursing care goals set and achieved for an assigned patient or group of patients.

NASA TLX: Performance

How successful do you think you were in accomplishing the nursing care goals set by yourself or someone else? How satisfied are you with your performance in accomplishing those goals?

Poor _____ **Good**

Content Validity Rating

Please **circle** the number that applies to this test item.

1 = not relevant
2 = unable to assess relevance without item revision
3 = relevant, but needs minor alterations
4 = very relevant and succinct

Comments

_____

_____

_____

_____

ID CODE # _____

FRUSTRATION LEVEL

Nursing Definition

Frustration level refers to a range of emotions experienced by a nurse incurred while providing nursing care to an assigned patient or group of patients.

NASA TLX: Frustration Level

How insecure, discouraged, irritated, stressed and annoyed versus secure, gratified, content, relaxed and complacent did you feel while working?

Low _____ **High**

Content Validity Rating

Please **circle** the number that applies to this test item.

1 = not relevant
2 = unable to assess relevance without item revision
3 = relevant, but needs minor alterations
4 = very relevant and succinct

Comments

_____

_____

_____

_____

PART II
INSTRUMENT EVALUATION

Directions

The procedure for evaluating the entire instrument is similar to the one that you followed for the individual test items. A definition of subjective mental workload is followed by the six test items of the NASA TLX. To evaluate the content validity of the entire instrument, you will be given the same four-point rating scale that was used in Part I.

At this point you have the opportunity to suggest the addition of test items, not included in the NASA TLX, that you think are important in measuring the subjective mental workload of critical care nurses. If you do want to add an item(s), please be as clear as possible by naming and describing the new item(s), using the Comments section for this purpose.

Nursing Subjective Mental Workload

Subjective mental workload is a nurse's perception of attention load incurred while providing patient care that culminates from the mental, physical, and temporal demands of care, and the effort, performance satisfaction, and frustration experienced in response to those patient care demands.

NASA TLX

Mental Demand

How much mental and perceptual activity, or attention, was required to care for your patients (e.g. thinking, deciding, calculating, remembering, watching, monitoring)? Were the patient care requirements easy or demanding, simple or complex, exacting or forgiving?

Low _____ **High**

Physical Demand

How much physical activity was required to care for your assigned patients (e.g. pushing, pulling, turning, controlling, activating, etc.)? Were the physical care requirements easy or demanding, light or strenuous, restful or laborious?

Low _____ **High**

Temporal Demand

How much time pressure did you feel due to the rate or pace at which your patients required nursing care? Was the pace of your work slow and leisurely or rapid and frantic?

Low _____ **High**

Effort

How hard did you have to work (mentally and physically) to accomplish your level of performance, given your performance goals?

Low _____ **High**

Performance

How successful do you think you were in accomplishing the nursing care goals set by someone else or yourself? How satisfied are you with your performance in accomplishing those goals?

Poor _____ **Good**

Frustration Level

How insecure, discouraged, irritated, stressed and annoyed versus secure, gratified, content, relaxed and complacent did you feel while working?

Low _____ **High**

ID CODE # _____

Content Validity Rating

Please **circle** the number that applies to the entire instrument.

1 = not relevant
2 = unable to assess relevance without item revision
3 = relevant, but needs minor alterations
4 = very relevant and succinct

Comments

DEMOGRAPHICS QUESTIONNAIRE

Please check one response in each of the following groups:

FUTURE PARTICIPATION

In the event that this study needs to be repeated due to extensive revision, would you agree to be a participant?

_____ Yes
_____ No

GENDER

_____ female
_____ male

RACE

_____ White
_____ Black
_____ Hispanic
_____ Other (please specify)

HIGHEST EDUCATION IN NURSING

_____ Diploma in Nursing
_____ Associate Degree in Nursing
_____ Baccalaureate Degree in Nursing
_____ Masters Degree in Nursing
_____ Doctorate in Nursing

Please fill in the blanks below:

LIST ALL OTHER DEGREES

_____

_____

YEARS OF EXPERIENCE IN CRITICAL CARE NURSING

_____ years

DATE OF BIRTH

___ ___ / ___ ___ / ___ ___

Appendix E

Informed Consent

I have been asked to participate in a research study conducted by Andrea Gregg, MSN, a doctoral student at the University of Alabama at Birmingham School of Nursing.

I understand that the purpose of the study is to assist the researcher in examining the relationships among subjective mental workload, experience, and education of cardiovascular critical care registered nurses.

I understand that I will be asked to complete a survey instrument designed to measure subjective mental workload, the NURSING TLX, following the first four hours of a work shift in the cardiovascular critical care unit where I normally work. Completing the NURSING TLX will require approximately fifteen minutes of my time.

I also understand that I will be asked to fill out a nurse demographic form. The nurse demographic form will ask general information such as age, gender, education, experience, and work schedule. Information about my work assignment on the day of testing, such as the volume of patients I cared for, and the particular shift that I was working, will be recorded by the researcher using a work demographics form.

I understand that any information that I give will remain anonymous and confidential. I understand that my name will be removed from the completed forms and that a number code will be used once my participation in the study

is complete. My ratings on the NURSING TLX and the information contained in the two demographic forms will be reviewed only by the researcher and the researcher's supervisory committee. Information that is reported from the study will be grouped so that individual participants, nursing units, and hospitals cannot be identified.

I understand that this study will not involve any personal harm. The information learned from this study may be used to gain insight into the subjective mental workload of registered nurses when providing care to critically ill patients.

I understand that my participation is totally voluntary and that I may withdraw from the study at any time. I understand that I will not receive any compensation, monetary or otherwise, for my assistance in this research.

_____ _____

Signature of Participant Date

Appendix F

Institutional Review Board Requests

IRB EXEMPTION APPLICATION - Revised 8-19-91

TITLE OF PROJECT: Relationship Among Subjective Mental Workload, Experience, and Educaton of Cardiovascular Critical Care Registered Nurses; Instrument Pretest
PRINCIPAL INVESTIGATOR: Andrea Gregg, MSN, RN
INVESTIGATOR'S SIGNATURE:_____TODAY'S DATE___
CAMPUS ADDRESS: Department School of Nursing
Building_____Rm_____Phone_____
OR HOME ADDRESS AND CAMPUS AFFILIATION_____
SOURCE OF FUNDS: State specific name of funding source
Government Agency_____Foundation_____
Corporation_____Other Personal

Mark the category or categories below which describe your research:

____1. Research conducted in established or commonly accepted educational settings, involving normal educational practices, such as (i) research on regular and special education instructional strategies, or (ii) research on the effectiveness fo or the comparison among instructional techniques, curricula, or classroom management methods.

__X__2. Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, unless: (i) information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and (ii) any disclosure of the human subject's responses outside the research could reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, or reputation.

____3. Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior that is not exempt under category (2), if: (i) The human subjects are elected or appointed public officials or candidates for public office; or (ii) federal statute(s) require(s) without exception that the confidentiality of the personally identifiable information will be maintained throughout the research and thereafter. Attach to this application a copy of any questionnaire to be used.

____4. Research involving the collection or study of existing data, documents, records, pathological specimens, or diagnostic specimens, if these sources ar publicly available or if the information is recorded by the Investigator in such a manner that subjects cannot be identified, directly or through identifiers linked to the subjects. Attach a specimens release form if applicable.

____5. Research and demonstration projects which are conducted by or subject to the approval of department of agency heads, and which are designed to study, evaluate, or otherwise examine: (i) Public benefit or service programs; (ii) procedures for obtaining benefits or services under those programs; (iii) possible changes in or alternatives to those programs or procedures; or (iv) possible changes in methods or levels of payment for benefits or services under those programs.

____6. Taste and food quality evaluation and consumer acceptance studies, (i) if wholesome foods without additives are consumed or (ii) if a food is consume that contains a food ingredient at or below the level and for a use found to be safe, or agricultural chemical or environmental contaminant at or below the level found to be safe, by the Food and Drug Administration or approved by the Environmental Protection Agency or the Food Safety and Inspection Service of the U.S. Department of Agriculture.

Please give a brief description of your project to explain the exemption:

THIS RESEARCH IS PART OF A LARGER DISSERTATION STUDY, AN DIS CONDUCTED FOR THE PURPOSE OF EXAMINING THE CONTENT VALIDITY OF THE NATIONAL AERONAUTICS SPACE ADMINISTRATION TASK LOAD INDEX (NASA TLX) FOR USE AMONG A CRITICAL CARE NURSING POPULATION. A NETWORK SAMPLE OF TEN DOCTORALLY PREPARED, CRITICAL CARE NURSES WILL BE SURVEYED FOR OPINIONS OF BOTH INDIVIDUAL TEST ITEMS AND THE ENTIRE INSTRUMENT; AN INTRODUCTORY LETTER EXPLAINS THE STUDY AND PARTICIPANT INVOLVEMENT. PARTICIPATION IS VOLUNTARY, IDENTIFICATIONS CODES ARE USED INSTEAD OF NAMES, AND ONLY GENERIC DEMOGRAPHIC DATE WILL BE REPORTED. THERE IS NO RISK OF INJURY OR PREJUDICE TO SUBJECTS.

EXPEDITED REVIEW: THE IRB APPLICATION

Principal Investigator: Andrea Gregg, MSN, RN

Title of Project: Relationship Among Subjective Mental Workload, Experience, and Education of Cardiovascular Critical Care Registered Nurses

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Please indicate by checking the appropriate space below the category or categories into which you believe your project falls:

___(1) Collection of hair and nail clippings, in a non-disfiguring manner; deciduous teeth; and permanent teeth if patient care indicates a need for extraction.

___(2) Collection of excreta and external secretions including sweat, uncannulated saliva, placenta removed at delivery, and amniotic fluid at the time of rupture of the membrane prior to or during labor.

___(3) Recording of data from subject 18 years of age or older using noninvasive procedures routinely employed in clinical practice. This includes the use of physical sensors that are applied either to the surface of the body or at a distance and to not involve input of matter or significant amounts of energy into the subject or an invasion of the subject's privacy. It also includes such procedures as weighing, testing sensory acuity, electrocardiography, electroencephalography, thermography, detection of naturally occurring radio-activity, diagnostic echography, and electroretinography. It does not include exposure to electromagnetic radiation outside the visible range for (for example x-rays, microwaves).

___(4) Collection of blood samples by venipuncture, in amounts not exceeding 450 milliliters in an eight week period and no more often than two times per week, from subjects 18 years of age or older and who are in good health and not pregnant.

___(5) Collection of both supra-and subgingival dental plaque and calculus, provided the procedure is not more invasive than routine prophylactic scaling of the teeth and the process is accomplished in accordance with accepted prophylactic techniques.

___(6) Voice recordings made for research purposes such as investigations of speech defects or subject's responses to questioning.

___(7) Moderate exercise by healthy volunteers.

___(8) The study of existing data, documents, records, pathological specimens, or diagnostic specimens.

__X__(9) Research on individual or group behavior or characteristic of individuals, such as studies of perception, cognition, game theory, or test development, where the investigator does not manipulate subject's behavior and the research will not involve stress to the subjects. Research involving sensitive matters such as sexual or political behavior may require full review. Expedited review is not appropriate if the subjects' responses, if known outside the research, could place them at risk of civil or criminal liability or damage their financial standing or employability.

___(10) Research on drugs or devices for which an investigational new drug exemption or an investigational device exemption is not required. NOTE: the Board may request full review if in their opinion the subject will be at a greater than minimal risk.

Appendix G

Content Validity Survey II

Subject Letter

Thank you for agreeing to participate in this second delphi study to determine the content validity of the Revised NASA TLX (National Aeronautics Space Administration Task Load Index) for use among critical care nurses. The results of the first Delphi study that you participated in supported content validity (0.05 significance level) for five of the six test items and the entire instrument. Qualitative suggestions however, led to revisions in the instrument that I believe warrant a second opinion. The revised instrument has been expanded from six to seven test items, now including Environmental Demand. The original Frustration Level test item has been expanded to Emotionalism. All of the remaining test items are conceptually the same, but some structure and semantic revisions have been made.

The original Introductory Information is enclosed in case you want to review it again. The format for rating content validity is the same as in the first Delphi study. In Part I, you are asked to evaluate the content validity of each the seven test items that comprise the NURSING TLX, Revised. In Part II, you are asked to evaluate the entire instrument for content validity.

Your opinion of the Revised NASA TLX is invaluable and will facilitate the future study of the subjective mental

workload of nurses. No compensation, monetary or otherwise, will be given for your participation. Opinions rendered by experts in this study will be kept confidential and anonymity will be maintained.

If you have any questions regarding what you are being asked to do, please feel free to contact me at work or at home. Please complete and return your ratings to me by _____. Again, I appreciate the time that you have contributed to this research endeavor.

PART I

TEST ITEM EVALUATION

The NASA TLX, revised for nursing, is comprised of seven test items: mental demand, physical demand, temporal demand, environmental demand (new), effort, performance, and emotionalism (formerly frustration level). The descriptive statements for each test item are followed by a visual analogue scale with semantic extremes; words on the left side reflect low subjective mental workload ratings and words to the right indicate high ratings.

Directions

A nursing definition for each test item is given, followed by the NASA TLX, Revised scale for that test item. Please rate each test item according to the extent that you believe it is a relevant component of subjective mental workload among critical care nurses. A rating of 4 indicates that you believe that a test item is very relevant and succinct. A rating of 1 indicates that you believe that a test item is not relevant.

Under the Comments section, suggestions for the addition/deletion of words or phases to the test item may be made, if in your opinion, such changes would make a test item more meaningful for critical care nurses. If you believe that a test item is not relevant (1), please indicate your rationale for suggesting its deletion.

ID CODE # _____

MENTAL DEMAND

Nursing Definition

Mental Demand is the amount of patient care information that needs to be cognitively processed by a nurse in order to provide care to an assigned patient or group of patients.

NASA TLX, Revised: Mental Demand

How much attention and cognitive activity was required to care for your patients (e.g. thinking, decision-making, remembering, monitoring, planning, problem-solving)?

Low _____ **High**

Content Validity Rating

Please **circle** the number that applies to this test item.

1 = not relevant
2 = unable to assess relevance without item revision
3 = relevant, but needs minor alterations
4 = very relevant and succinct

Comments

_____

_____

_____

_____

ID CODE # _____

PHYSICAL DEMAND

Nursing Definition

Physical Demand is the amount of muscular activity that is required of a nurse when providing nursing care to an assigned patient or group of patients.

NASA TLX, Revised: Physical Demand

How much muscular activity/exercise was required to care for your patients (e.g. pushing, pulling, turning, running, walking, lifting)?

Low _____ **High**

Content Validity Rating

Please **circle** the number that applies to this test item.

1 = not relevant
2 = unable to assess relevance without item revision
3 = relevant, but needs minor alterations
4 = very relevant and succinct

Comments

_____

_____

_____

_____

ID CODE # _____

TEMPORAL DEMAND

Nursing Definition

Temporal Demand is the time pressure experienced by a nurse due to the rate or pace at which nursing care must be provided to an assigned patient or group of patients.

NASA TLX, Revised: Temporal Demand

How much time pressure did you experience due to the rate or pace of nursing care required by your patients (e.g., slow or rapid, time to spare or too much too do)?

Low _____ **High**

Content Validity Rating

Please **circle** the number that applies to this test item.

1 = not relevant
2 = unable to assess relevance without item revision
3 = relevant, but needs minor alterations
4 = very relevant and succinct

Comments

_____

_____

_____

_____

ID CODE # _____

ENVIRONMENTAL DEMAND

Nursing Definition

Environmental Demand is the influence of the nursing unit's atmosphere and resources on a nurse's ability to provide patient care.

NASA TLX, Revised: Environmental Demand

How did the atmosphere and resources of the nursing unit influence your ability to provide nursing care (e.g., noise, traffic, tension, supplies, equipment)?

Supportive _____ **Disruptive**

Content Validity Rating

Please **circle** the number that applies to this test item.

1 = not relevant
2 = unable to assess relevance without item revision
3 = relevant, but needs minor alterations
4 = very relevant and succinct

Comments

_____

_____

_____

_____

ID CODE # _____

EFFORT

Nursing Definition

Effort is the level of energy (mental and physical) exerted by a nurse in order to care for patients.

NASA TLX, Revised: Effort

How hard did you have to work in response to the needs of your patients (e.g., was the care routine or novel to you, did you have enough help)?

Minimum _____ **Maximum**

Content Validity Rating

Please **circle** the number that applies to this test item.

1 = not relevant
2 = unable to assess relevance without item revision
3 = relevant, but needs minor alterations
4 = very relevant and succinct

Comments

_____

_____

_____

_____

ID CODE # _____

PERFORMANCE

Nursing Definition

Performance is the self-evaluation of nursing care quality achieved by the nurse.

NASA TLX, Revised: Performance

What level of quality do you think you achieved in caring for your patients (e.g., optimal or deficient)?

High _____ **Low**

Content Validity Rating

Please **circle** the number that applies to this test item.

1 = not relevant
2 = unable to assess relevance without item revision
3 = relevant, but needs minor alterations
4 = very relevant and succinct

Comments

_____

_____

_____

_____

ID CODE # _____

EMOTIONALISM

Nursing Definition

Emotionalism refers to a range of positive and negative feelings experienced by a nurse while providing nursing care to patients.

NASA TLX, Revised: Emotionalism

What type of feelings did you experience overall while providing care to your patients (e.g., content or frustrated, gratified or discouraged, calm or anxious, congenial or annoyed)?

Positive_____**Negative**

Content Validity Rating

Please **circle** the number that applies to this test item.

1 = not relevant
2 = unable to assess relevance without item revision
3 = relevant, but needs minor alterations
4 = very relevant and succinct

Comments

_____

_____

_____

_____

PART II
INSTRUMENT EVALUATION

Directions

The procedure for evaluating the entire instrument is similar to the one that you followed for the individual test items. A definition of subjective mental workload is followed by the seven test items of the NASA TLX, Revised. To evaluate the content validity of the entire instrument, you will be given the same four-point rating scale that was used in Part I.

At this point you have the opportunity to suggest the addition of test items, not included in the NASA TLX, that you think are important in measuring the subjective mental workload of critical care nurses. If you do want to add an item(s), please be as clear as possible by naming and describing the new item(s), using the Comments section for this purpose.

NURSING SUBJECTIVE MENTAL WORKLOAD

Subjective Mental Workload is a nurse's perception of attention load experienced while providing patient care that accrues from the mental, physical, temporal and environmental demands of care, and the effort, performance, and emotionalism responses to these demands

NASA TLX, Revised

Mental Demand

How much attention and cognitive activity was required to care for your patients (e.g., thinking, decision-making, remembering, monitoring, planning, problem-solving)?

Low _____ High

Physical Demand

How much muscular activity/exercise was required to care for your patients (e.g., pushing, pulling, turning, running, walking, lifting)?

Low _____ High

Temporal Demand

How much time pressure did you experience due to the rate or pace of nursing care required by your patients (e.g., slow or rapid, time to spare or too much too do)?

Low _____ High

Environmental Demand

How did the atmosphere and resources of the nursing unit influence your ability to provide patient care (e.g., noise, traffic, supplies, equipment)?

Supportive _____ Disruptive

Effort

How hard did you have to work in response to the needs of your patients (e.g., was the care routine or novel to you, did you have enough help)?

Minimum _____ Maximum

Performance

What level of quality do you think you achieved in caring for your patients (e.g., optimal or deficient)?

High _____ Low

Emotionalism

What type of feelings did you experience overall while providing care to your patients (e.g., satisfied or dissatisfied, content or frustrated, gratified or discouraged, calm or anxious, congenial or annoyed)?

Positive _____ Negative

ID CODE # _____

Content Validity Rating

Please **circle** the number that applies to the entire instrument.

1 = not relevant
2 = unable to assess relevance without item revision
3 = relevant, but needs minor alterations
4 = very relevant and succinct

Comments

Appendix H

Nursing Task Load Index

INTRODUCTION

This research focuses on your experiences during the first four hours of your work shift. Right now I am going to describe the technique that will be used to examine your experience of providing care to patients. In the most general sense I am examining the "workload" you experienced. Workload is a difficult concept to define precisely, but a simple one to understand generally. The factors that influence your experience of workload come from the patient care itself, your feelings about your own performance, how much effort you put in, or the emotions you felt. The workload contributed by different patient care procedures may change as you get more familiar with the procedures, or with the type of patients who require those procedures. These procedures are components of workload and are relatively easy to conceptualize and evaluate. However, the mental components of workload are more difficult to measure.

Since mental workload is something that is experienced individually by each person, there are no effective "rulers" that can be used to estimate the workload of different activities. One way to find out about mental workload is to ask people to describe the feelings they experienced. Because mental workload may be caused by many different factors, I would like you to evaluate several of

them individually rather than lumping them into a single global evaluation of overall mental workload. This set of seven rating scales was developed for you to use in evaluating your mental workload while caring for patients during the first four hours of your work shift. Please read the descriptions of the scales carefully. Note that some of the scale endpoints go from Minimal to Maximum, while others go from High to Low.

INSTRUCTIONS

1. Consider the four hours of patient care that you have just completed when rating each of the seven scale questions.
2. Each of the scales have two endpoint descriptors that describe the range of the scale. Pay particular attention to these endpoint descriptors when entering your rating.
3. Read a test item, then place an "X" on the respective scale at the point that you believe matches your experience during these four hours. Rate all seven scale items.
4. If you have any questions, please ask me before proceeding with your ratings.

Nursing Task Load Index

Please indicate your rating by marking an 'X' on each scale.

MENTAL DEMAND

How much attention and cognitive activity (e.g., thinking, decision-making, concentrating, remembering, monitoring, planning, problem-solving) were required to care for your patients?

Low **High**

|_____|

PHYSICAL DEMAND

How much muscular activity/exercise (e.g., pushing, pulling, turning, running, walking, lifting) was required to care for your patients?

Low **High**

|_____|

TEMPORAL DEMAND

How much time pressure did you experience due to the rate or pace (e.g., slow with time to spare versus rapid with overlapping tasks) of nursing care required by your patients?

Low **High**

|_____|

ENVIRONMENTAL DEMAND

How did the nursing unit conditions (e.g., noise, traffic, tension, supplies, equipment) influence your ability to provide patient care?

Supportive **Disruptive**

|_____|

EFFORT

How much energy was needed to provide care to your patients (e.g., how hard did you have to work)?

Minimal **Maximum**

|_____|

PERFORMANCE

What level of quality (e.g., optimal or deficient) do you think you achieved in caring for your patients?

High **Low**

|_____|

EMOTIONALISM

What type of feelings (e.g., satisfied or dissatisfied, content or frustrated, gratified or discouraged, calm or anxious, congenial or annoyed) did you experience overall while providing care to your patients?

Positive **Negative**

|_____|

Appendix I

Subject Notification Letter

Your name has been randomly selected to participate in a research study on the mental workload of cardiovascular critical care nurses. The study will be conducted in your unit during the three week period of _____. Closer to that time period, you will be notified of the date and time of your scheduled participation. Should you not wish to participate in the study, please check the box below and place in the envelope on your unit marked 'SUBJECTIVE MENTAL WORKLOAD STUDY'.

To assist you in making a decision regarding your participation, I have included information about the study under cover of this letter. Look over the forms and note any questions that you may have. I will answer your questions on the scheduled date of your test. You may complete the Informed Consent and Nurse Demographic forms in advance of that date if you wish. DO NOT COMPLETE THE NURSING TLX OR THE WORK DEMOGRAPHIC FORMS NOW. Those forms will be completed on your scheduled date and time.

[ ] I do not wish to participate in the study.

Subject Schedule Notification

You have been scheduled to completed your subjective mental workload survey on _____ at _____am/pm. Do not complete the Nursing TLX or the Work Demographic forms until I arrive on your unit. Should all the conditions of this research not be met on this date, you will be scheduled for another date.

GRADUATE SCHOOL
UNIVERSITY OF ALABAMA AT BIRMINGHAM
DISSERTATION APPROVAL FORM

Name of Candidate Andrea C. Gregg

Major Subject Nursing Service Administration

Title of Dissertation Relationship Among Subjective Mental Workload, Experience, and Education of Cardiovascular Critical Care Registered Nurses

Dissertation Committee:

Nena F. Sanders, Chairman

Robert A. Scott

Linda W. Duke

Cynthia Carter Ford

Director of Graduate Program Elizabeth Stullenbarger

Dean, UAB Graduate School W. A. Bailey

Date May 11, 1993

PS-1428