THE RELATIONSHIPS AMONG PERSONALITY, STRESS,

AND SITUATION AWARENESS: THE EFFECT OF

SITUATION AWARENESS TRAINING

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THE RELATIONSHIPS AMONG PERSONALITY, STRESS, AND SITUATION AWARENESS: THE EFFECT OF SITUATION AWARENESS TRAINING

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Feruzan Syrus Irani, daughter of Dr. Syrus D. and Zarina S. Irani, was born March 1, 1981, in Mumbai (Bombay), India. She graduated from Maneckji Cooper Education Trust School in 1997 and attended Hassaram Rijhumal (HR) College of Commerce and Economics in Mumbai, India for five years; earning a Bachelor of Commerce (Accounting) degree in 2002 (Mumbai University). She came to the United States of America and joined the University of West Georgia in Carrollton, Georgia in 2002 and graduated with a Master of Business Administration (M.B.A.) degree in August 2003. After working as a restaurant manager for a year, she entered the doctoral program at Auburn University in August 2004.

DISSERTATION ABSTRACT

THE RELATIONSHIPS AMONG PERSONALITY, STRESS,

AND SITUATION AWARENESS: THE EFFECT OF

SITUATION AWARENESS TRAINING

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Conventionally, the study of situation awareness (SA) has predominantly been confined to the field of aviation. However, SA has been recognized to be of vital importance in information-processing and decision-making in a variety of other occupations. The present study extends the work of previous authors by conducting research on the effect of personality and stress on the SA of workers in a high-intensity job other than aviation. This study developed emergent medical scenarios and the SA requirements for each scenario. Although, this SA measure demonstrated acceptable content validity, it failed to meet reliability requirements.

Data regarding SA, stress (physiological and psychological), and personality were collected from nursing school students who were in the junior/senior year in their

programs. A randomized experimental design was used to collect data and test the study hypotheses. In addition to participating in the medical scenarios, the participants were also provided with situation awareness training which aimed at improving their situation awareness, contingency planning, communication and teamwork skills, and stress management.

Path analysis was used to test the relationships among personality, stress, and SA and the effect of the situation awareness training on these relationships. In accordance with previous research, the study demonstrated that psychological stress was positively associated with personality factors such as neuroticism. However, due to measurement problems with the SA scales and minimal reactivity of the physiological stress measures, no conclusions could be drawn regarding the relationship of SA with either personality or stress (physiological and psychological). Additionally, results also showed that the situation awareness training did not have the hypothesized effect on the stress-SA relationship.

This calls into question the model of personality, stress, and SA proposed by the study. However, before the model, or any of its components, is discarded, further analyses should be performed using new or refined SA and stress instruments. Opportunities for future research are discussed in detail and ideas for the improvement of the study design are proposed.

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CHAPTER 1

LITERATURE REVIEW AND HYPOTHESES

Introduction

The fast pace of society today has made its way into the workplace. The business world places a great deal of emphasis on one's ability to cope with ever-changing environments and being able to make split-second critical decisions based on considerable information coming from numerous sources. Due to constantly and complexly changing environments, a key component of many jobs today is concerned with obtaining and maintaining good situation awareness (SA). SA not only encompasses awareness and understanding of appropriate situational information, but it also requires projection of future outcomes (Endsley, 1995a).

Traditionally, the study of SA has predominantly been confined to the field of aviation (Redden, 2001). However, SA has been recognized to be of vital importance to a variety of other occupations such as anesthesiology (e.g., Gaba, Howard, & Small, 1995), air traffic control (e.g., Endsley & Rodgers, 1994), large-systems operations (e.g., Wirstad, 1988), tactical and strategic systems (e.g., Klein, 1989) and infantry operations (Matthews, Strater, & Endsley, 2004). In each of these occupations, individuals are required to perceive the state of their environment, understand the meaning of what they perceive, and project a course of action (the three components of SA; Redden, 2001). SA incorporates an overall understanding of the situation and thus forms the basis for

decision-making (Redden, 2001). Information processing and decision-making have been extensively studied in the management literature (e.g., Kovera, 1999; Mitchell, Smith, Seawright, & Morse, 2000; Oluic-Vukovic, 2001; Windschitl & Young, 2001; Wood, 2001); however few studies have taken a holistic view of the concept of SA (e.g., considering all three components of SA simultaneously; Redden, 2001). Generating and maintaining SA is a necessity in making adequate decisions in critical situations (Endsley, 1999; Klein, 2000). Further, it is essential for effective functioning in complex and dynamic situations and has been closely linked to human decision-making and performance (Endsley & Garland, 2000; Matthews, et al., 2004). Therefore, it is of vital importance to study SA along with its antecedents and consequences, in order to reduce human error, especially in critical situations.

Gaba, et al. (1995) proposed that SA should be extended beyond the field of aviation to the field of anesthesiology because of the similarity in the domain characteristics. These similarities include dynamism, complexity, high information load, variable workload, and risk. This argument can be extended to other aspects of medicine including nursing, intensive care, surgery, and emergency medicine (Gaba, et al., 1995). As in aviation, most preventable accidents in anesthesiology and other medical fields can be attributed to human factors, rather than mechanical problems (Gaba, et al., 1995). Hence, in the interest of improving safety in the medical field and avoiding preventable and sometimes fatal accidents, it is essential to study human performance in these dynamic environments (Cooper, Newbower, & Kitz, 1984; Cooper, Newbower, Long, & McPeek, 1978). The present research examines SA in an emergency medical setting,

focusing on both environmental and individual factors (such as stress and personality) related to SA.

Even though stress has been identified as a major limiter to obtaining good SA (Endsley, 1995), there is no empirical support for this in previous literature. The present project seeks to fill this gap and further the understanding of the impact of stress on individual reactions during emergency situations. Occupational stress constitutes a costly, destructive, and widespread problem at the individual and organizational levels (National Institute for Occupational Safety & Health, 2002), and its impact on health and well-being is believed to be increasing (Burrow, 2002). Stress has been linked to major diseases such as coronary heart disease (CHD) and diseases of the circulatory system (e.g., strokes). Stress has also been implicated in the development of cancer (Hendrix, 1991). Thus, it would seem that stress intervention and prevention is imperative, especially identifying those individuals at higher risk and those environmental demands that exacerbate it. This would be beneficial, not only for individual health and well-being, but it will also ensure that good decisions are made in critical/emergency situations.

Purpose

The purpose of this dissertation was to explore the effects of personality and situation awareness training on the relationship between SA and stress. Specifically, it was hypothesized that the negative relationship between SA and stress would be affected by certain personality factors (conscientiousness and neuroticism), and that this negative relationship would be diminished by situation awareness training. These relationships

were explored under the auspices of situation awareness theory (Endsley, 1995a), threat-rigidity theory (Staw, Sandelands, & Dutton, 1981), need for closure theory (Kruglanski & Webster, 1996), and theory of stress, appraisal, and coping (Lazarus & Folkman, 1984).

Results of this project will provide opportunities for advancement of empirical research in the fields of human factors research, stress research, and employee outcomes research. The project could be useful on many practical fronts such as (a) helping hospital executives to understand the importance of individual and environmental variables needed to improve employee performance, well-being, and health; (b) enabling hospital executives to get insights about how to manage stressful situations effectively by managing the different individual aspects; (c) providing a viable training option to hospital executives to enhance employee performance, well-being, and health; (d) enabling nurse practitioners to be better prepared for their stressful profession by improving their SA in emergent medical situations, contingency planning skills, communication skills, teamwork skills, and stress management; and (e) improving the overall quality of healthcare by improving patient safety and the well-being and health of the healthcare professionals.

Background of Situation Awareness (SA)

Various definitions have been proposed for SA (e.g., Endsley, 1988a; Fracker, 1988; Sarter & Woods, 1995). Much of the previous research defined SA as a state of knowledge (Endsley, 1995a). This view of SA does not include a person's complete knowledge; instead it deals only with the portion that is concerned with the state of a

dynamic environment (Endsley, 1995a). True SA encompasses a much wider spectrum than just being aware of information about the environment. It includes a more in-depth understanding of the situation and the projection of future outcomes (Endsley, 1995a). Endsley (1995a, p. 36) presented a comprehensive definition of SA which states that "situation awareness is the perception of the elements in the environment within a volume of time and space, the comprehension of their meaning, and the projection of their status in the near future."[1] According to this definition, SA includes three sequential components: perception of the elements in the environment (Level 1 SA), comprehension of the situation (Level 2 SA), and projection of future status (Level 3 SA; Endsley, 1995a). The present research concurs with Endsley's (1995a) model which shows the sequential levels of SA and Redden (2001) who empirically tested the Endsley model. Figure 1 illustrates this sequence which suggests that Level 1 SA (perception) forms the foundation for Level 2 SA (comprehension). Further, Level 3 SA (projection) cannot occur until Level 1 and Level 2 SA have been satisfied.

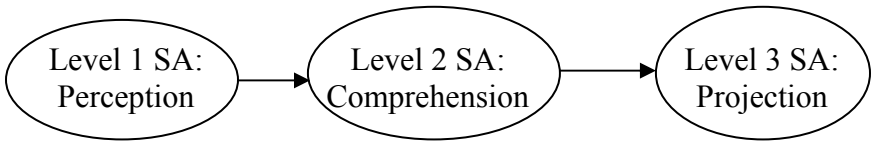


Figure 1. The sequential nature of situation awareness

Perception (Level 1 SA)

The foundational step in achieving SA is to perceive the relevant elements in the environment. This level of SA must be satisfied before any higher level of SA can occur (Endsley, 1995a; Redden, 2001). The environment, especially a high intensity

[1] For more applications of this definition see Endsley, 1987, 1988b, 1995b.

environment, may contain considerable information, some of which may be irrelevant to the worker trying to achieve SA in order to complete a particular task. Perception involves making the distinction between relevant and irrelevant information. Information may be derived from observation of the environment (direct and indirect observation through the use of the five human senses), communications with others (verbal and non-verbal), or from other knowledge sources such as the Internet or reference books. Human attention has limitations and numerous pieces of information may all compete for that limited attention, leading to information overload (Redden, 2001). Information overload, lack of training and experience, lack of awareness of applicable databases, and dynamic situations are just some of the elements that make it difficult to perceive all of the important aspects of a situation.

Take the case of a woman coming to a medical practitioner with complaints of difficulty conceiving a child. The medical practitioner perceives that the female patient shows signs of acne, apple-shaped obesity, difficulty with weight loss, high blood pressure, hirsutism, and sugar and carbohydrate cravings. This would constitute Level 1 SA (perception). Failure to notice some of the woman's symptoms may have either left the medical practitioner unable to move on to the next stage of SA (comprehension) or led to the medical practitioner making an incorrect diagnosis of the problem (wrong comprehension).

Comprehension (Level 2 SA)

Once the foundational perception of information occurs, it is possible to achieve the next level of SA (Level 2 SA). Comprehension (Level 2 SA) is the synthesis of the

information perceived during Level 1 SA. It goes beyond just perception of environmental information and includes an in-depth understanding of the significance of the information. Level 1 and Level 2 SA help individuals form a holistic picture of the environment by helping them to perceive and comprehend the meaning of relevant information. In the example mentioned above, from the various symptoms displayed by the female patient, the medical practitioner may comprehend (Level 2 SA) that her symptoms are consistent with Insulin Resistance Syndrome (Syndrome X). Failure to perceive all of the woman's symptoms correctly may have led the medical practitioner to assume that the woman simply had a problem with her diet. Therefore, failed perception of situational information would lead to failed comprehension of the problem.

Projection (Level 3 SA)

The third and highest level of SA is the ability to project a future course of action, based on knowledge of the environmental information and comprehension of the situation (Level 1 and Level 2 SA). Continuing the above example, once the medical practitioner has perceived the woman's symptoms (Level 1 SA) and comprehended that they are consistent with Insulin Resistance Syndrome (Level 2 SA), the next step should be to project (Level 3 SA) that a blood test needs to be conducted to support the diagnosis and, if it is supported, then the female patient should also be tested for Polycystic Ovary Syndrome (PCOS). PCOS is a treatable form of infertility and can be combated with weight loss and insulin stabilizing drugs such as Metformin (Glucophage®). However, if the medical practitioner was functioning with poor perception and comprehension, the patient might be prescribed incorrect solutions.

Hence, SA is comprised of far more than just being aware of the environmental information (Level 1 SA). It includes understanding what the various pieces of information mean as a whole (Level 2 SA) and using that comprehension to predict a future course of action (Level 3 SA). The ability to achieve all three levels of SA is affected by individuals' experience, training, abilities, and characteristics of the environment/situation such as stress and workload (Endsley, 1995a).

Stress

Because of its relationships with several costly individual and organizational outcomes (Schuler, 1982), stress has received considerable attention in the literature. Stress can be defined as "a common condition wherein job related factors interact with the worker to change (disrupt or enhance) his/her psychological or physiological condition such that the person (mind and/or body) is forced to deviate from normal functioning" (Beehr & Newman, 1978).

Psychological Consequences of Stress

"Psychological stress occurs when the situation is perceived as thwarting or as potentially thwarting to some motive state, thus resulting in affective arousal and in the elicitation of regulation processes aimed at the management of the affect" (Lazarus & Baker, 1956, p. 22). In other words, when under stress, individuals might perceive that the situation (stimulus) obstructs or threatens to obstruct some goal that they are motivated to achieve. This causes their negative affect (intervening variable) to increase and in an effort to cope with this negative affect, behavior (response) occurs (Hermann,

1966). This sequence of events is further illustrated in Figure 2. The time sequence of each event is indicated by the numbers in the figure.

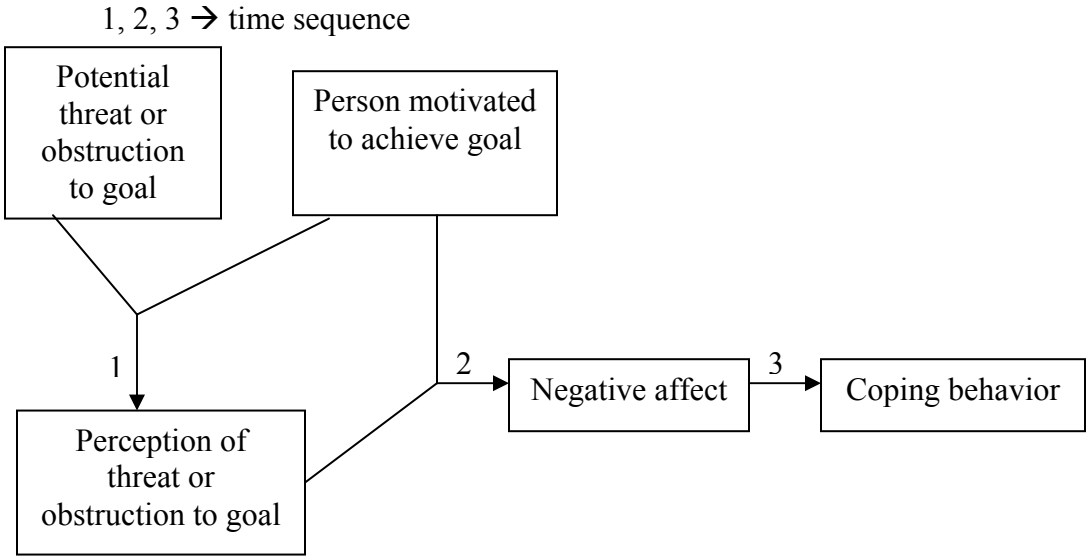


Figure 2. Sequence of events in the psychological stress process (Hermann, 1966, p. 382)

According to this sequence of events, the amount of negative affect is a function of the individual's motivation to achieve the goal. In this case, negative affect is used as a collective term for various emotional states such as anxiety, fear, frustration, hostility, and tension. This translation of stimulus to emotion is termed the appraisal process (Arnold, 1960; Lazarus, 1963).

According to the psychological model of stress and disease, environmental conditions are appraised as either threatening or challenging by individuals who then exhibit associated emotional responses (Cohen, Kessler, & Gordon, 1995; Lazarus & Folkman, 1984; Mason, 1975). These emotional responses, in turn, may trigger physiological responses which place individuals at greater risk for disease.

Physiological Consequences of Stress

Occupational stress constitutes a costly, destructive, and widespread problem at the individual and organizational levels (National Institute for Occupational Safety & Health, 2002), and its impact on health and well-being is believed to be increasing (Burrow, 2002). As mentioned earlier, according to the psychological model of stress and disease, when environmental conditions are appraised as either threatening or challenging by individuals, they will exhibit associated emotional responses (Cohen, Kessler, & Gordon, 1995; Lazarus & Folkman, 1984; Mason, 1975). These emotional responses, in turn, may trigger physiological responses that place individuals at greater risk for disease. The stress, appraisal, and coping model (Lazarus & Folkman, 1984) describes the intervening psychological processes between exposure to potentially stressful conditions and physiological activation. When situations are appraised as threatening, individuals are expected to react with greater negative emotion (psychological), which, in turn, leads to physiological responses that may influence the onset or progression of disease (Lazarus & Folkman, 1984). From the above it can be surmised that psychological stress and physiological stress will be highly correlated.

Several psychophysiological measures that are sensitive to stressors such as cognitive requirements of complex tasks and mental workload, have been used in previous research (e.g., Hankins & Wilson, 1998; Wilson, 2001, 2002b; Wilson & Eggemeier, 1991). The fight-or-flight response (also known as the stress response) involves two major systems working together in the body: the sympathetic nervous system (SNS) and the endocrine system (Hendrix, 1991). These two systems, working

together in response to stress, direct increased blood flow to the brain and muscles while blood flow to the skin, intestines, and extremities is reduced. Smaller blood vessels are constricted resulting in increased blood pressure. In order to gain energy, the stress reaction causes a mobilization of glucose (blood sugar) and the fatty acids stored in the body, which are dumped into the bloodstream. This reaction also causes a narrowing of vision, increased heart rate, reduced digestion, increased underarm perspiration, deepened breathing, and increased palm sweating (Albrecht, 1979; Hendrix, 1991; Selye, 1976).

Previous research has looked at physiological reactions such as heart rate, blood pressure, skin conductance, skin temperature, and respiration rate as markers of physiological stress. For example, Lepore, Revenson, Weinberger, Weston, Frisina, Robertson, Portillo, Hones, and Cross (2006) studied the difference in the effects of social stressors on cardiovascular reactivity (heart rate and blood pressure) in Black and White women. Iwanaga, Yokoyama, and Seiwa (2000) studied the impact of personal responsibility and latitude for Type A and B individuals on heart rate as a measure of physiological stress.

Galvanic Skin Response or skin conductance is another measure of physiological stress used in previous research (e.g., Andreassi, 1995; Cowings & Toscano, 2000; Cowings, Toscano, DeRoshia, & Tauson, 1999; Cramer, 2003; Nomikos, Opton, Averill, & Lazarus, 1968; Smith & Principato; 1982; Storm, Myre, Rostrup, Stockland, Lien, & Raeder, 2002). For example, Cowings and Toscano (2000) used physiological measures such as heart rate and skin conductance to test whether autogenic-feedback training exercise is superior to promethaszine for control of motion sickness. Similarly, Cowings,

Toscano, DeRoshia, and Tauson (1999) stated that responses to environmental stimuli could be objectively represented by physiological data. They used physiological measures such as heart rate and skin conductance to test the effects of command and control vehicle operation environment on soldier health and performance. Past research revealed that skin conductance reflects the changes in the sympathetic nervous system due to an emotional state (Edelberg, 1967; Storm, et al., 2002). For example, Storm, et al., (2002) showed that skin conductance fluctuations were useful for monitoring the perioperative stress among patients.

As mentioned earlier, stress has been linked to major diseases such as coronary heart disease (CHD) and diseases of the circulatory system (e.g., strokes). Stress has also been implicated in the development of cancer (Hendrix, 1991). Thus, it would seem that stress intervention and prevention is imperative, especially identifying those individuals at higher risk and those environmental demands that exacerbate it. Additionally, it would be very useful to identify other consequences of high stress, other than just the physiological effects.

Stress and Situation Awareness

Endsley's (1995a) SA model proposes that both individual differences as well as features of the task environment are associated with SA. Individual differences include a person's information processing method which is influenced by abilities, biases, preconceptions, experience, and training. Features of the task environment, such as workload, stressors, and complexity, are proposed to correlate with an individual's SA. Stressors that are associated with individuals' SA can be divided into two types: (a)

physical stressors, such as noise, vibration, heat/cold, boredom, fatigue, and cyclical changes; and (b) social psychological stressors, such as fear or anxiety, uncertainty, importance of events, consequences, mental load, and time pressure (Hockey, 1986; Sharit & Salvendy, 1982).

In the analyses of disaster, psychological stress often depends on the anticipation of something harmful happening in the future (Lazarus, 1963). This anticipation of potential harm is key to the concept of threat (Lazarus, 1963). Threat has been defined as "an environmental event that has impending negative or harmful consequences for the entity." (Staw, et al., 1981, p. 502). Lazarus (1963) regards threat as "the central intervening variable in psychological stress" (p. 200). Miller (1953) defined stress as a threat involving any energetic, extreme, or unusual stimulation which causes some significant change in behavior. Hall and Mansfield (1971) who reported that the state of the internal system of either an individual or an organization could change due to a threatening external event, viewed stress as a reaction to threat. The threat-rigidity theory (Staw, et al., 1981) suggests that stress, anxiety, and arousal are the immediate consequences of threat situations and can be used as manipulation checks for threatening stimuli. Gladstein and Reilly (1985) used stress as a reaction to and a manipulation check on threat. They successfully showed that an increase in threat was related to a corresponding increase in stress and that stress could be used as a manipulation check for threatening stimuli.

For example, if person A shouts at person B in anger, the shouting would constitute the threat and person B would experience stress as a result of that threat. Thus,

the stress experienced by person B could be used as a manipulation check to test whether the situation actually constituted a threat to person B. During threat situations, in addition to experiencing psychological stress and anxiety, individuals also become physiologically activated (aroused). According to the threat-rigidity theory (Staw, et al., 1981), individuals, groups, and organizations tend to behave rigidly under threatening situations. Since stress is a direct result of threatening situations, the relationship between threat and rigidity is applicable to stress.

The threat-rigidity theory (Staw, et al., 1981) states that under threatening situations, information processing may be restricted because of a narrowing in the field of attention, reduced number of channels of information used, or an oversimplification in information codes. This threat-rigidity hypothesis about the restriction of information processing due to a threat situation was tested by Gladstein and Reilly (1985) using observational and questionnaire data collected from 128 second-year MBA students playing a management simulation game in an experimental setting. Using a repeated measures MANOVA, they concluded that threat conditions were associated with a restriction in information processing.

From the above arguments, it can be summarized that the consequences of a threat situation imply reduced SA; thus, threat/stress will be negatively related to individuals' SA. This negative relationship between stress and the 3 levels of SA is illustrated in Figure 3 and further explained in the following paragraphs.

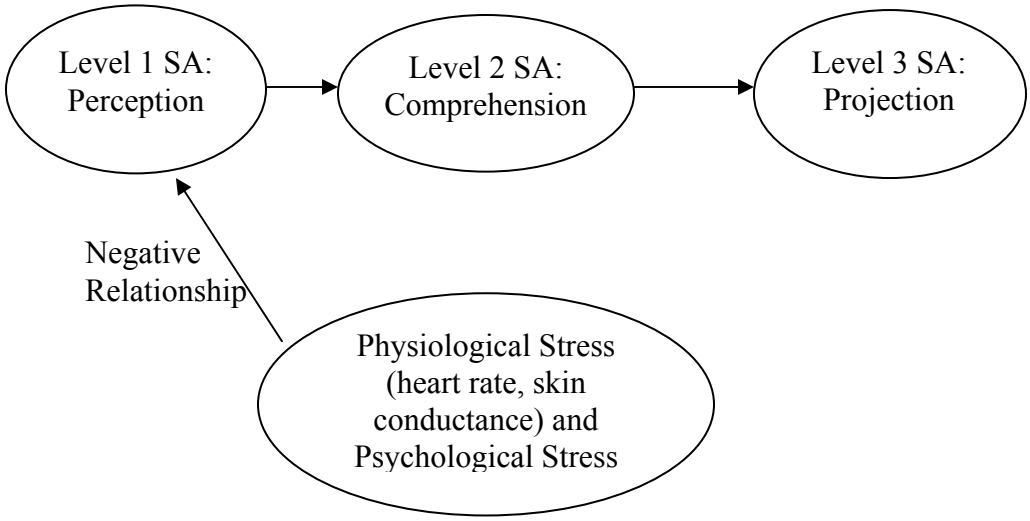


Figure 3. The negative relationship between stress and the three levels of situation awareness

Stress and Perception (Level 1 SA)

Stressors can influence Level 1 SA in two potential ways: tunnel vision and premature closure. First, and predominantly, stress interferes with an individual's ability to identify and discriminate among visual stimuli (Staw, et al., 1981). Stress causes people to taper their field of attention to include only a limited number of central aspects (Bacon, 1974; Baddeley, 1972; Eysenck, 1982; Hockey, 1970). This effect has been called *cognitive tunnel vision* (Sheridan, 1981). Cognitive tunnel vision causes important peripheral information to be ignored in favor of other dominant information about the individual's perceived central task (Endsley, 1995a). In some cases, this ignored peripheral information can lead to severe consequences. In the medical field, severe consequences may prove life-threatening.

Stress has also been shown to encourage individuals to strive towards premature closure. This can result in decisions that are not based on sufficient information (Janis, 1982b; Keinan, 1987; Keinan, & Friedland, 1987; Kruglanski & Webster, 1996). The need for cognitive closure refers to "individuals' desire for a firm answer to a question and an aversion toward ambiguity" (Kruglanski & Webster, 1996; p. 264). The need for closure theory (Kruglanski & Webster, 1996; Webster & Kruglanski, 1994), suggests that stressors such as time pressure, workload, and environmental noise are antecedents of the desire for premature closure. According to this theory, need for closure may instill two general tendencies: the urgency tendency (i.e., the inclination to "seize" on closure quickly) and the performance tendency (i.e., the desire to perpetuate closure through the preservation of or "freezing" on past knowledge and safeguarding future knowledge).

The theory suggests that individuals with a strong desire to attain closure have a tendency to leap to judgment based on inconclusive evidence, exhibit rigidity of thought, and exhibit reluctance to consider views dissimilar to their own (Kruglanski & Webster, 1996). The theory proposes that the need for closure encourages people to seize on early and dominant information and immediately freeze on it. This freezing, in turn, may cause individuals to become impervious to subsequent data and thus process less information (low Level 1 SA) before arriving at a decision. The need for closure theory has been used in previous research to explain various phenomena such as the extent of information processing, hypothesis generation, the strivings for consensus in group settings, and resistance to persuasion (e.g., Kruglanski, 1996; Kruglanski & Webster, 1996; Mayseless & Kruglanski, 1987; Rubini & Kruglanski, 1997; Webster &

Kruglanski, 1997; Webster, Kruglanski, & Pattison, 1997). For example, Mayseless and Kruglanski (1987), considered the link between the extent of information processing and the need for closure. They had participants perform a tachistoscopic recognition task of identifying barely visible digits on a screen. They induced a need for closure condition, a neutral control condition, and a need to avoid closure condition. The authors concluded that the extent of informational search (information processing) was lowest in the need for closure condition, intermediate in the control condition, and highest in the need to avoid closure condition.

The above arguments suggest that stress will have a significant negative association with the initial perception of the environment (Level 1 SA).

Hypothesis 1a: Physiological stress, as measured by heart rate, will be inversely related to Level 1 SA (perception), such that an increase in heart rate will be related to a decrease in perception.

Hypothesis 1b: Physiological stress, as measured by skin conductance, will be inversely related to Level 1 SA (perception), such that an increase in skin conductance will be related to a decrease in perception.

Hypothesis 2: Psychological stress will be inversely related to Level 1 SA (perception), such that an increase in psychological stress will be related to a decrease in perception.

Stress, Comprehension, and Projection (Level 2 and Level 3 SA)

Stress has also been shown to have a negative relationship with working memory capacity and retrieval (Hockey, 1986). Working memory can be

considered a complex system used for both information storage and computational processing of that information (Hansen, Johnsen, & Thayer, 2003). This memory is stored in the prefrontal area of the brain and functions best when the mind is calm (Mauri, Sinforiani, Bono, & Vignati, 1993). When threatened (stressed), the brain's alarm system (the amygdala) sends a signal to the prefrontal lobes through a neural pathway, which shuts off focus and creativity (Mauri, et al., 1993). The body is mobilized (through cortisol eruptions) to combat the external threat. This drains resources from the working memory and redirects them to the senses (Mauri, et al., 1993).

According to Endsley (1995a), the level of working memory load is positively related to the second and third aspects of SA (comprehension and projection), such that SA is negatively affected by tasks that involve high working memory load. High mental workload has been considered an important stressor in many dynamic systems and has been known to adversely affect SA (Endsley, 1995a; Jones & Endsley, 1996; Stanton & Young, 2000; Young & Stanton, 1997). High mental workload has been considered a causal factor in approximately 30% of SA errors (Stanton & Young, 2000).

Previous research related physiological and psychophysiological measures, such as heart rate, heart rate variability, and blood pressure rate to memory performance, mental workload and attention (see e.g., Fairclough, Venables, & Tattersall, 2005; Svensson & Wilson, 2002; Wilson, 2002a[2]). For example, heart rate has been shown to

[2] For more information see Backs & Seljos, 1994; Boucsein & Backs, 2000; Ekberg, Eklund, Tuvessen, Ortengren, Odenrick, & Ericson, 1995; Hancock & Desmond, 2000; Middleton, Sharma, Agouzoul, Sahakian, & Robbins, 1999; Redondo & Delvalleinclan, 1992; Schellekens, Sijtsma, Vegter, & Meijman, 2000; Veltman & Gaillard, 1998; Vincent, Craik, & Furedy, 1996.

increase with higher levels of mental workload (Wilson, 2002a). This increased heart rate would be indicative of the stress reaction caused by the stressor (mental workload), and would, in turn, have a negative effect on comprehension and projection.

However, since the levels of SA are sequential (Redden, 2001), the relationship between stress and Level 2 SA (comprehension) is suspected to be mediated through Level 1 SA (perception). Similarly, the relationship between stress and Level 3 SA (projection) is suspected to be mediated through Level 1 SA (perception) and Level 2 SA (comprehension). These mediated relationships may rule out significant direct negative relationships between stress and Level 2 SA (comprehension) and Level 3 SA (projection). The full mediation of the stress-Level 1 SA-Level 2 SA-Level 3 SA will be tested.

Hypothesis 3a: Physiological stress, as measured by heart rate, will be inversely related to Level 2 SA (comprehension), but this relationship will be mediated by Level 1 SA. Specifically, an increase in heart rate will be indirectly related to a decrease in comprehension through the mediation of perception.

Hypothesis 3b: Physiological stress, as measured by skin conductance, will be inversely related to Level 2 SA (comprehension), but this relationship will be mediated by Level 1 SA. Specifically, an increase in skin conductance will be indirectly related to a decrease in comprehension through the mediation of perception.

Hypothesis 4: Psychological stress will be inversely related to Level 2 SA (comprehension), but this relationship will be mediated by Level 1 SA. Specifically, an

increase in psychological stress will be indirectly related to a decrease in comprehension through the mediation of perception.

Hypothesis 5a: Physiological stress, as measured by heart rate, will be inversely related to Level 3 SA (projection), but this relationship will be mediated by Level 1 and Level 2 SA. Specifically, an increase in heart rate will be indirectly related to a decrease in projection through the mediation of perception and comprehension.

Hypothesis 5b: Physiological stress, as measured by skin conductance, will be inversely related to Level 3 SA (projection), but this relationship will be mediated by Level 1 and Level 2 SA. Specifically, an increase in skin conductance will be indirectly related to a decrease in projection through the mediation of perception and comprehension.

Hypothesis 6: Psychological stress will be inversely related to Level 3 SA (projection), but this relationship will be mediated by Level 1 and Level 2 SA. Specifically, an increase in psychological stress will be indirectly related to a decrease in projection through the mediation of perception and comprehension.

The Role of Personality

"Personality is that pattern of characteristic thoughts, feelings, and behaviours that distinguishes one person from another and that persists over time and situation." (Phares, 1991, p. 4). According to Ryckman (1982), personality is the "sum of biologically based and learnt behaviour which forms the person's unique responses to environmental stimuli" (pp. 4-5). In other words, an individual's personality will dictate how that individual will react to environmental stimuli (such as stress). Hence, the role of

personality must be understood when studying the relationship between stress and SA. Various theories of personality have been proposed to explain differences in individual reactions to situations. One such theory is the Five-Factor model of personality (Costa and McCrae, 1992; Revelle & Loftus, 1992). This theory suggests that there are five overall dimensions of personality that are stable across a lifespan: neuroticism, extraversion, openness to experience, agreeableness, and conscientiousness (Costa and McCrae, 1992; Revelle & Loftus, 1992). When relating the above personality dimensions to stress, literature most often cites conscientiousness and neuroticism as the main dimensions affecting stress (e.g., Birch & Kamali, 2001; Deary & Blenkin, 1996; Penley & Tomaka, 2002; Tellegen, 1985). Hence, for the purpose of the present study, only the effects of conscientiousness and neuroticism will be considered.

Conscientiousness

Conscientiousness refers to the extent to which individuals are personally competent, dutiful, self-disciplined, deliberate, careful, diligent, and dependable (Costa & McCrae, 1992). Frequent descriptors for conscientious individuals include purposeful, strong willed, determined, punctual, and reliable (Judge, Martocchio, & Thoresen, 1997). Conscientiousness is a measure of individuals' goal-directed behavior and their control over impulses. Previous research shows evidence that conscientious individuals have a strong will to achieve (Digman & Takemoto-Chock, 1981). The above descriptors of conscientiousness indicate that this would be an important trait to consider while studying the relationship between stress and SA. Conscientiousness may have an impact on how

individuals perform and maintain SA under stressful situations. Conscientious individuals may be able to maintain good SA irrespective of stress levels.

In previous research, conscientiousness has been hypothesized to have a negative relationship with stress because conscientious individuals tend to have positive feelings of personal achievement, successfully deal with stress by utilizing problem-solving coping strategies, and apply themselves to solving the practical aspects of a stressor (Deary & Blenkin, 1996; Penley & Tomaka, 2002). Hence, in the present study, conscientiousness is hypothesized to have a negative relationship with stress.

Hypothesis 7a: Conscientiousness will be negatively associated with stress (physiological and psychological), such that highly conscientious individuals will experience less stress than individuals low in conscientiousness.

As mentioned earlier, conscientiousness refers to individual characteristics such as persistence, planfulness, and carefulness (Barrick & Mount, 1991). In previous research, conscientiousness has been likened to responsibility and need for achievement (Booth-Kewley & Vickers, 1994; Costa, McCrae, & Dye, 1991). Heinstrom (2003) studied the impact of the Big Five personality characteristics on information behavior and found that conscientious individuals engaged in productive information behavior. She established that conscientious individuals were willing to put forth more effort in order to obtain relevant information than their less conscientious counterparts. Since Level 1 SA (perception) is related to information seeking and awareness, it would seem that conscientiousness would be positively related to perception.

Hypothesis 7b: Conscientiousness will be positively associated with perception, such that highly conscientious individuals will attain higher perception than individuals low in conscientiousness.

However, since conscientiousness has been hypothesized to have a negative relationship with stress, and stress has been hypothesized to have a negative relationship with SA; the relationship between conscientiousness and SA is suspected to be partially mediated through stress. That is, highly conscientiousness individuals will tend to experience less stress, which, in turn, will enhance SA. This mediated relationship might rule out a significant direct positive relationship between conscientiousness and SA. The full mediation of the conscientiousness-stress-SA relationship will be tested. From the above arguments it would seem that conscientiousness will not only have a direct positive relationship with SA, but that it will also be indirectly related to SA through stress.

Hypothesis 7c: Stress (physiological and psychological) will partially mediate the positive relationship between conscientiousness and all three levels of SA, such that highly conscientious individuals will experience less stress than low conscientious individuals, which in turn will increase their SA.

Neuroticism

Neuroticism has also been termed as negative affectivity or emotional stability in the literature. It is a measure of an individual's emotional control. It refers to a general lack of positive psychological adjustment and emotional stability (Judge, et al., 1997). Individuals with high levels of neuroticism exhibit fearfulness, anxiousness, and depression. They are more emotionally reactive and show strong or aversive responses to

stimuli in their environment (Eysenck, 1967; Eysenck & Eysenck, 1985; Stelmack, 1990).

Neuroticism is related to the tendency to appraise environmental stimuli as stressful, inefficient ways of coping with stress, and a disposition to experience aversive emotional states (Widiger, Hurt, Frances, Clarkin, & Gilmore, 1984). Several studies have hypothesized the positive relationship between neuroticism and the experience of stress; i.e., highly neurotic individuals will tend to experience more stress than low neurotic individuals (e.g., Birch & Kamali, 2001; Deary & Blenkin 1996; Tellegen, 1985). According to Tellegen (1985), neuroticism tends to inhibit one's ability to adapt, by functioning as a warning system which is activated by perceptions of environmental uncertainty. Thus, highly neurotic individuals are more likely to view stimuli as a threat to them and experience higher levels of stress as a result (Nasurdin, Ramayah, & Kumaresan, 2004).

Some previous literature suggests that neuroticism may not be a good predictor of physiological stress. For example, in their study on dispositional affect and work-related stress, Schaubroeck, et al., (1992) found that neuroticism was not correlated with any of their hypothesized physiological stress outcomes (palmer sweat, diastolic blood pressure, systolic blood pressure, heart rate, skin temperature, and adrenaline). However, in the present research, it was felt that since neuroticism has been shown to be strongly related to psychological stress (e.g., Birch & Kamali, 2001; Deary & Blenkin 1996; Tellegen, 1985), this relationship would translate to a physiological reaction. Therefore,

neuroticism is hypothesized to have a positive relationship with physiological, as well as, psychological stress.

Hypothesis 8a: Neuroticism will be positively associated with stress (physiological and psychological), such that highly neurotic individuals will experience more stress than individuals low in neuroticism.

Recently, Wallace and Newman (1997, 1998) proposed a cognitive model of neuroticism, which concentrated on the attentional processes of highly neurotic individuals. They suggested that optimal functioning required an ongoing regulation of negative thoughts. However, the emotionality of neuroticism has its basis in unsuccessful regulation of such cognitions (dysregulation). They suggested that highly neurotic individuals are extremely susceptible to automatic orienting of attention ("any instance where attention and cognitive resources are redirected from an ongoing process to a distractor stimuli", pp. 139-140). This automatic orienting of attention is responsible for disrupting the regulatory processes necessary for optimal functioning. Additionally, Heinstrom (2003) proposed a negative relationship between neuroticism and information behavior. She found that highly neurotic individuals engaged in less productive information behavior than their more stable counterparts. Since Level 1 SA (perception) is related to information seeking and awareness, it would seem that neuroticism would be negatively related to perception; and through perception to the other two levels of SA (comprehension and projection).

There is some recent research that suggests that there might actually be a more positive relationship between neuroticism and performance during tasks that require

greater effort (e.g., Smillie, Yeo, Furnham, & Jackson, 2006). This research suggests that if neurotic individuals are completely immersed in their tasks then they would not have many cognitive resources to spare for anything else, and this in turn would prevent dysregulation. However, because the present study is not concerned with increasingly time-consuming and busy tasks, it is hypothesized that neuroticism will have a negative relationship with SA.

However, since neuroticism has been hypothesized to have a positive relationship with stress and stress has been hypothesized to have a negative relationship with SA; the relationship between neuroticism and SA is suspected to be mediated through stress. This mediated relationship might rule out significant direct negative relationships between neuroticism and SA. The full mediation of the neuroticism-stress-SA relationship will be tested.

Hypothesis 8b: Stress (physiological and psychological) will mediate the negative relationship between neuroticism and all three levels of SA, such that highly neurotic individuals will experience more stress than low neurotic individuals, which in turn will negatively affect SA.

Situation Awareness Training

Since SA has been recognized to be of vital importance to making adequate decisions in critical situations (Endsley, 1999; Klein, 2000), training individuals to maintain good SA would be extremely useful, especially during emergency situations requiring quick decisions. This training should provide participants with knowledge about SA, what it means, and how to go about gaining and maintaining it, despite adverse

environmental conditions. However, it may not always be possible for an individual to maintain perfect SA. Participants should be taught to actively seek information from peers and outsiders who are part of their environment (Endsley & Robertson, 2000; Taylor, Endsley, & Henderson, 1996). This would be especially helpful to those participants who work in teams. Each team member might have different pieces of information, and communication and good teamwork will permit all pieces of environmental information to be shared, thus improving the SA of all team members. Thus, communication and teamwork skills should be emphasized as helpful tools to build good SA (Salas, Prince, Baker, & Shrestha, 1995).

In addition to communication and teamwork skills, the training should also emphasize active contingency planning as a tool to help maintain good SA (Endsley & Robertson, 2000). Active contingency planning has been shown to be critical to good SA, especially for Level 3 SA (projection; Endsley & Robertson, 2000) and requires individuals to be continuously planning for changes in the environmental conditions; and their actions, should the predicted changes occur. This will prevent them from being taken by surprise and maintain good SA, especially Level 3 SA (projection). Additionally, since previous research (Endsley, 1995a) and the present study hypothesize stress to have a negative effect on SA, the training program should give information on stress and coping. Information should be provided to the participants about stress management techniques that they can implement in their daily lives so as to better deal with stressful situations.

It is expected that a training program encompassing the above elements will enable the participants to better deal with stress and to maintain better situation awareness during emergent situations. Hence, it is hypothesized that situation awareness training will diminish the previously hypothesized negative relationship between stress and the three levels of SA.

Hypothesis 9: Situation awareness training will diminish the negative relationship between stress (physiological and psychological) and the three levels of SA (perception, comprehension, and projection).

Summary of Hypotheses and Hypothesized Model

Table 1 presents a summary of the hypotheses, and Figure 4 illustrates the hypothesized model, for this dissertation.

Table 1

Summary of Hypotheses

Hypotheses
Hypothesis 1a. Physiological stress, as measured by heart rate, will be inversely related to Level 1 SA (perception), such that an increase in heart rate will be related to a decrease in perception.
Hypothesis 1b. Physiological stress, as measured by skin conductance, will be inversely related to Level 1 SA (perception), such that an increase in skin conductance will be related to a decrease in perception.
Hypothesis 2. Psychological stress will be inversely related to Level 1 SA (perception), such that an increase in psychological stress will be related to a decrease in perception.
Hypothesis 3a. Physiological stress, as measured by heart rate, will be inversely related to Level 2 SA (comprehension), but this relationship will be mediated by Level 1 SA. Specifically, an increase in heart rate will be indirectly related to a decrease in comprehension through the mediation of perception.
Hypothesis 3b. Physiological stress, as measured by skin conductance, will be inversely related to Level 2 SA (comprehension), but this relationship will be mediated by Level 1 SA. Specifically, an increase in skin conductance will be indirectly related to a decrease in comprehension through the mediation of perception.
Hypothesis 4. Psychological stress will be inversely related to Level 2 SA (comprehension), but this relationship will be mediated by Level 1 SA. Specifically, an increase in psychological stress will be indirectly related to a decrease in comprehension through the mediation of perception.
Hypothesis 5a. Physiological stress, as measured by heart rate, will be inversely related to Level 3 SA (projection), but this relationship will be mediated by Level 1 and Level 2 SA. Specifically, an increase in heart rate will be indirectly related to a decrease in projection through the mediation of perception and comprehension.
Hypothesis 5b. Physiological stress, as measured by skin conductance, will be inversely related to Level 3 SA (projection), but this relationship will be mediated by Level 1 and Level 2 SA. Specifically, an increase in skin conductance will be indirectly related to a decrease in projection through the mediation of perception and comprehension.

Hypotheses

Hypothesis 6. Psychological stress will be inversely related to Level 3 SA (projection), but this relationship will be mediated by Level 1 and Level 2 SA. Specifically, an increase in psychological stress will be indirectly related to a decrease in projection through the mediation of perception and comprehension.

Hypothesis 7a. Conscientiousness will be negatively associated with stress (physiological and psychological), such that highly conscientious individuals will experience less stress than individuals low in conscientiousness.

Hypothesis 7b. Conscientiousness will be positively associated with perception, such that highly conscientious individuals will attain higher perception than individuals low in conscientiousness.

Hypothesis 7c. Stress (physiological and psychological) will partially mediate the positive relationship between conscientiousness and all three levels of SA, such that highly conscientious individuals will experience less stress than low conscientious individuals, which in turn will increase their SA.

Hypothesis 8a. Neuroticism will be positively associated with stress (physiological and psychological), such that highly neurotic individuals will experience more stress than individuals low in neuroticism.

Hypothesis 8b. Stress (physiological and psychological) will mediate the negative relationship between neuroticism and all three levels of SA, such that highly neurotic individuals will experience more stress than low neurotic individuals, which in turn will negatively affect SA.

Hypothesis 9. Situation awareness training will diminish the negative relationship between stress (physiological and psychological) and the three levels of SA (perception, comprehension, and projection).

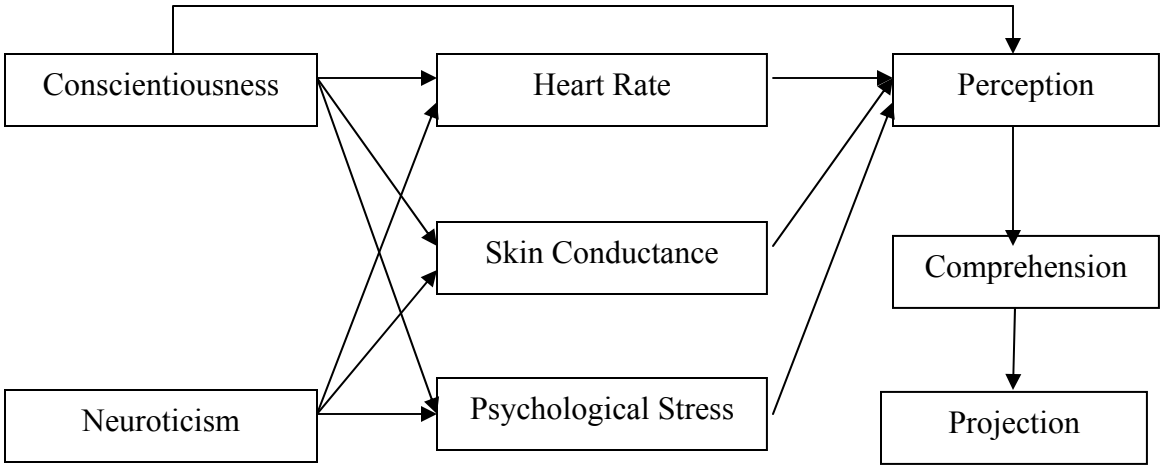


Figure 4. The relationships among personality, stress, and the three levels of situation awareness

CHAPTER 2

METHOD

Site and Participants

The proposed hypotheses were tested using data collected from students enrolled in the School of Nursing at two large Southeastern Universities. A total of 93 participants took part in the study (44 from one university and 49 from the other); although data from only 92 participants could be used (one participant had to be dropped due to incomplete data). The majority of the participants (98%) were in their junior year at their respective university (second/third semester of nursing school) although some seniors (who were in their preceptorship) also participated.

Approximately 87% were female and 89% were Caucasian. The participant ages ranged from 20-47 years (M = 24.24 years, SD = 4.97 years). Their reported grade point averages (GPA; on a scale from 1-4) ranged from 2.3 to 4.0 overall GPA (M = 3.4, SD = .36) and 2.4 to 4.0 nursing major GPA (M = 3.22, SD = .39).

Study Design

Two SMEs (experienced nurse educators in the School of Nursing at Auburn University) helped to develop six medical scenarios (each approximately three to five minutes long). These scenarios required the participants to work with Laerdal's advanced patient simulator, SimMan®, and were based on pre-existing scenarios in the nursing simulation manual provided with SimMan®. Specifically, the provided scenarios

were approximately 15 to 30 minutes in length and were modified to meet the time frame (three to five minutes) and stress induction necessary for this study. SimMan® is a portable and advanced patient simulator for team training. SimMan® has realistic anatomy and clinical functionality. It includes software and an interactive technologically advanced manikin.

The same SMEs were also used to generate the SA questionnaire which contained questions pertaining to perception, comprehension, and projection (see Appendix A for details of the scenarios and the SA questions). In order to test the relationship between SA and stress, the scenarios were designed to induce different levels of stress: two constant stress scenarios (creating low stress), two increasing stress scenarios (creating medium stress), and two increasing stress scenarios with a distracter (creating high stress). The constant stress scenarios consisted of a simple medical situation with little, if any, environmental noise. The increasing stress scenarios introduced more complicated medical situations with changing environmental information. The final two scenarios added yet another dimension of complication to the medical scenario, by including a distracter (irate physician or upset family member), in addition to rapidly changing environmental information.

In order to test the effect of the situation awareness training (details about the training are given in the Measures section), the six scenarios were then randomly divided into two blocks (A and B). Each block consisted of a total of three scenarios (one each for low, medium, and high stress, randomly selected). A randomized experimental design (Shadish, Cook, & Campbell, 2002; Stone, 1978; Stone-Romero, 2002, 2006; Stone-

Romero & Rosopa, 2008) was used in the present study. As per this design, approximately half of the participants were randomly assigned to the treatment group and the rest formed the control group. The treatment group participated in three randomly selected scenarios of differing stress levels (scenario block A; scenarios presented in a random order to counterbalance any order effects) prior to the situation awareness training. This group then participated in the training, followed by the remaining three scenarios (scenario block B; scenarios presented in a random order). The control group participated in all six scenarios (scenario blocks A and B, presented in a random order) prior to the situation awareness training. The data from scenario blocks A and B for the treatment group were compared to the data obtained from scenario blocks A and B for the control group, in order to analyze the effect of the training program on the stress-SA relationship.

A total of 27 teams participated in this study (14 in the treatment group and 13 in the control group). Each team consisted of two to four randomly assigned members. Only one team at a time participated in the scenario simulation. Each team was required to work with SimMan® during the scenarios. SimMan's® medical condition was manipulated in accordance with the requirements of the different scenarios (see situation awareness in the measures section and Appendix A for details of the scenarios and their development). The manikin was placed in a hospital-like room and was attached to a patient monitor (with touch-screen technology; see Figure 5). Each team was required to attend to SimMan's® medical needs until the scenario was stopped (see Appendix A for the pre-determined stopping times). Team members then answered the situation

awareness questionnaire pertaining to the scenario they most recently participated in. This procedure was applied to all six scenarios.

Note: The simulation was run by a nurse practitioner, who was hidden behind a screen to maintain authenticity of the hospital setting.

Figure 5. SimMan® setup with patient monitor

Procedure

Before beginning the scenarios, demographic (see Appendix D) and personality (NEO-FFI; see Appendix C) information were collected and baseline measures of physiological stress (heart rate and skin conductance), and psychological stress (state anxiety; see Appendix B) were obtained (details of these scales are provided in the measures section).

Treatment group. The treatment group participated in three scenarios of differing stress levels (block A scenarios; randomly chosen out of the total possible six and presented in a random order) prior to attending the situation awareness training. They participated in the remaining three scenarios (block B scenarios; presented in a random order) after the situation awareness training.

Control group. The control group participated in all six scenarios (block A and block B scenarios; presented in a random order) prior to attending the situation awareness training. As per the agreement with the Nursing Schools at the two universities, the control group members were also provided with the situation awareness training. Due to this, it was not possible to allow the same time gap between block A and block B scenarios that the treatment group had (approximately three hours, required for the training). Instead, the control groups took a 5 minute break between the block A and block B scenarios and participated in the three hour training session upon completion of all six scenarios.

In accordance with the SAGAT methodology (Endsley, 1995; described further in the measures section), at the end of each scenario, everything was frozen (all screens/patient monitors blanked out) and the simulation was stopped. During this freeze frame all participants were asked the same set of fixed questions pertaining to all three levels of SA required in the scenario in which they most recently participated. At this time, participants also completed the State Anxiety questionnaire (psychological stress; described further in the measures section). Throughout the entire simulation exercise, physiological stress measures were collected using the SenseWear^{TM} armband (skin conductance; described further in the measures section) and the Actiheart monitor (heart rate; described further in the measures section). These data were used to study the relationships among personality (conscientiousness and neuroticism), stress, and SA.

In addition to the simulation, the study participants also took part in the custom designed Situation Awareness Training (SAT) program (see measures section for further

details). They were provided with a training packet containing the training DVDs, a set of earphones, some self-assessment tools (communication assertiveness, active listening skills inventory, communication apprehension inventory, and Type A-B personality inventory), and a stress management techniques handout. They were required to go to the computer lab where they received the training via a pre-recorded DVD.

The order of data collection for each team in the treatment and control groups is presented in Figures 6 and 7.

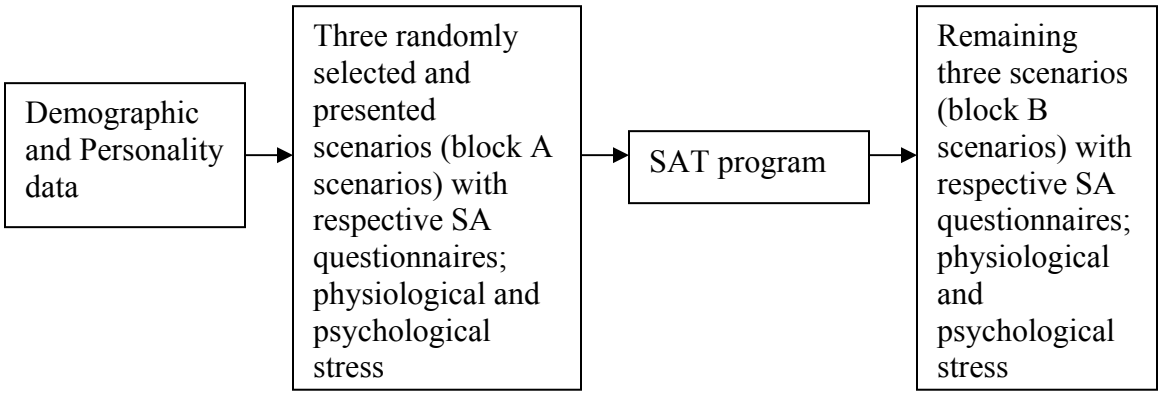


Figure 6. The order of data collection for each team in the treatment group

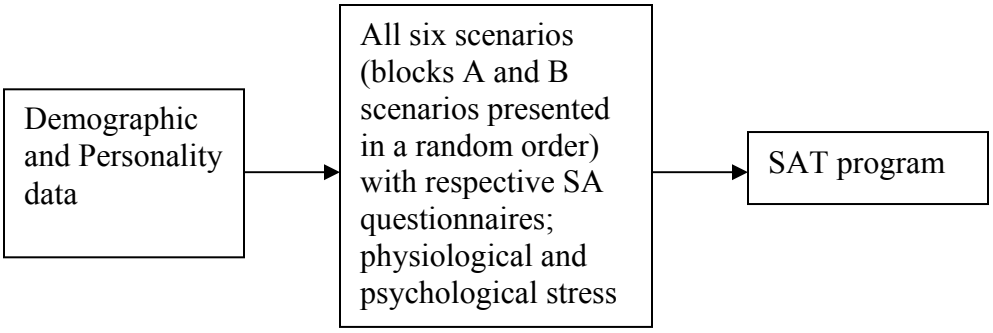


Figure 7. The order of data collection for each team in the control group

Measures

Situation Awareness (SA)

The Situational Awareness Global Assessment Technique (SAGAT; Endsley, 1987, 1988b, 1990a, 1995b) was utilized to measure participants' SA. The freeze technique (where scenarios are paused at pre-established times and all screens/patient monitors are blanked out) was employed in order to collect SAGAT information. In the present study, everything was frozen (all screens/patient monitors blanked out) at the end of each scenario (see Appendix A for the pre-determined stopping times) and the participants were required to answer questions testing their SA (see Appendix A).

SAGAT is a global methodology that assesses all elements of SA based on a comprehensive assessment of a worker's SA requirements (Endsley, 1987, 1988b, 1990a, 1995b). It involves the development of simulation scenarios and questionnaires testing participants' SA during those scenarios. This methodology has been shown to have empirical validity (Endsley, 1995b), predictive validity (Endsley, 1990b), and content validity (Endsley, 1990d). Computerized versions of SAGAT have been developed for air-to-air tactical aircraft (Endsley, 1990c), and advanced bomber aircraft (Endsley, 1989). Though SAGAT has been utilized primarily in the field of aviation, its basic methodology is generic and applicable in other contexts (Endsley, 1995b). According to Endsley (1995b), every context will have different SA requirements which need to be determined in order to use SAGAT outside of the aviation field. In the present study, this was done using subject matter experts (SMEs). As mentioned earlier, two SMEs (experienced nurse educators in the School of Nursing at Auburn University) were used

to generate six simulated medical scenarios based on the nursing simulation manual provided with SimMan®. These same SMEs then generated a list of SA requirements (all three levels; See Appendix A for details of the six scenarios and their respective SA questionnaires) pertaining to these six scenarios. This produced six scales each for perception, comprehension, and projection (one per scenario). A paper-and-pencil version of the SA scale was administered to the participants during the freeze periods at the end of each scenario.

Example items from the scale include "Did your patient appear to be upset at the beginning of the scenario?" (perception); "What is your patient likely suffering from?" (comprehension); and "What must you do in order to ease your patient's complaints?" (projection). Each of these questions was presented in a multiple choice format. In order to obtain an SA score for each participant, the questions pertaining to the three levels of SA were scored by comparing them to the correct answers determined during the questionnaire generation phase. The percentage of correct responses was computed for the perception, comprehension, and projection scales, for each of the scenarios. This methodology for computing participants' SA is consistent with prior SA research (e.g., Endsley & Kaber, 1999; Marshak, Kuperman, Ramsey, & Wilson, 1987; Redden, 2001).

Content validity of the SA questionnaire was calculated according to the procedure outlined by Schneider and Schmitt (1986). Initially, 10 items were developed for each of the perception and projection scales; and 1 item for each of the comprehension scales. The content validity ratio for each SA item was determined using responses from six SMEs (experienced nurse educators in the School of Nursing at

Auburn University) who were asked to classify the SA items according to perception, comprehension, and projection (definitions of these terms were provided along with a brief training session). These ratios were then tested for statistical significance using tables developed by Lawshe (1975). If an item was not identified as one of the SA levels ($p < .05$), it was dropped from the SA test. Using this criterion, two to four questions were deleted from each of the perception questionnaires, none from the comprehension questionnaires, and three to six questions from the projection questionnaires (see Appendix A for the final scales). The overall Content Validity Index was 0.99.

Since all the items in the SA scales were dichotomous in nature (either correct or incorrect answer), their reliabilities were computed using the KR-20 (Kuder & Richardson, 1937) formula. This is consistent with previous research which has used dichotomous SA scales (Redden, 2001). Each of the six scenarios had its own perception, comprehension, and projection scales; that is, in all, there were six perception, six comprehension, and six projection scales. Unfortunately, none of these scales met reliability requirements prescribed by previous research, which suggests that an alpha of .70 is the lower acceptable bound for good reliability (Nunnally, 1978; Nunnally & Bernstein, 1994; Streiner, 2003). In fact, some of the perception (Level 1 SA) scales had negative reliabilities ($\alpha = -.1$ to $\alpha = .28$) due to a negative average covariance among the items; while those that were positive were very low, and hence not acceptable. Since there was only one item per scenario for comprehension (Level 2 SA), a measure of internal consistency could not be computed. The reliabilities for the six

projection (Level 3 SA) scales ranged from α =.62 to α = .80, and were mostly in the acceptable range (> .70).

However, since a pilot test could not be performed for the SA questionnaires (reasons for the lack of a pilot test are discussed further in the discussion section), this reliability information was not available until after data collection was complete. Further, because the lack of reliability afflicted almost all of the SA scales, it was decided not to remove any of them from the study model as this would greatly reduce the hypotheses tests.

Psychological Stress

The State Anxiety scale of the State Trait Anxiety Inventory (STAI) Form Y (Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983) was used to measure the level of psychological stress (see Appendix B). The State Anxiety scale evaluates feelings of apprehension, tension, nervousness, and worry (Spielberger, et al., 1983). Results of laboratory procedures have shown the score on this scale to increase in response to psychological stress (Spielberger, et al., 1983). This scale is comprised of 10 anxiety-present and 10 anxiety-absent (reverse scored) items which measure, on a 4-point Likert-type scale (ranging from 1 = not at all to 4 = very much so), how respondents feel "right now, at this moment." Examples items from this scale include “I feel upset” and “I feel at ease” (reverse scored).

The test-retest reliability of the State Anxiety scale (tested on high-school students) was relatively low, ranging from .34 for females to .62 for males (Spielberger, et al., 1983). These relatively low stability coefficients were expected for this scale

because “a valid measure of state anxiety should reflect the influence of unique situational factors that exist at the time of testing” (Spielberger, et al., 1983; p. 13). The alpha coefficients of the State Anxiety scale, measuring internal consistency, provide a more meaningful index of reliability than the test-retest reliability. These alphas were computed using formula KR-20 as modified by Cronbach (1951). The alphas were computed using data from working adults (in three age groups), college students, high school students, and military recruits; and ranged from .86 to .95 with a median coefficient of .93, and were typically higher when the scale was administered under conditions of psychological stress (Spielberger, et al., 1983). In the present study, the state anxiety measure was administered a total of eight times; once at the end of each of the six scenarios, once before the bock A scenarios and once before the block B scenarios. The reliabilities for this scale ranged from $\alpha = .92$ to $\alpha = .96$ and were well within the acceptable range (> .70).

Physiological Stress

For the purpose of the present study, physiological stress was measured using skin conductance and heart rate. Skin conductance was measured through the use of the SenseWear™ armband manufactured by BodyMedia, Inc. Study participants were required to wear this armband five minutes prior to the simulation to establish a baseline skin conductance, as well as, during the simulation activity. Skin conductance was recorded at 15 second intervals and stored within the device, from where it was downloaded to a computer via a standard USB connection.

The skin conductance sensor has two hypoallergenic stainless steel electrodes integrated into the underside of the armband connected to a circuit that measures the skin's conductivity between the two electrodes. The skin's conductance of a current is measured by applying a low level electric voltage to the skin. Skin conductivity is affected by emotional stimuli and the perspiration from physical activity (Liden, Wolowicz, Stivoric, Teller, Vishnubhatla, Pelletier, & Farringdon, 2002). In a previous study, the skin conductance measured on the upper arm by the SenseWear™ armband was benchmarked against the more traditional fingertip skin conductance (Kasabach, Pacione, Stivoric, Teller, & Andre, 2002). The results demonstrated that although the armband skin conductance was significantly less sensitive than a skin conductance placed on the finger or palm, it nonetheless provided a linear analogy to digital values for conductance (Liden, Wolowicz, Stivoric, Teller, Kasabach, Vishnubhatla, Pelletier, Farringdon, & Boehmke, 2002). Using 150 value sets, one for each minute of the trials, Liden, Wolowicz, Stivoric, Teller, Kasabach, et al. (2002) tested the reliability of the armband on an individual wearing the same armband participating in identical protocols on different days. Results showed no statistically significant difference between the sets in 92% of the set pairs. In the present study, it was not possible to calculate test-retest reliability of skin conductance since the six scenarios (during which skin conductance readings were taken) were designed to generate differing levels of stress, and were, thus, not equivalent.

Heart rate was monitored via the Actiheart Monitor (9.5 grams, 32.4 mm in diameter x 18.7 cm in length; Mini Mitter™ , Bend, OR). Study participants were

required to wear the Actiheart monitor five minutes prior to the simulation to establish a baseline heart rate and also during the simulation activity. The Actiheart monitor is designed to attach to the chest with two biocompatible electrocardiograph (ECG) electrodes which are to be placed on either side of the heart parallel to the space between the fourth and fifth ribs. The Actiheart monitor digitizes the ECG signal and calculates the heart rate from the true R-to-R interval, i.e. the cycle between two consecutive R-waves. Heart rate was recorded at 15 second intervals and stored within the device, from where it was downloaded to a computer via a standard USB connection.

Previous research has shown the Actiheart monitor to have good reliability (ICC = .993) for heart rates ranging from 30 to 250 beats per minute (bpm) in adults (Brage, Brage, Franks, Ekelund, & Wareham, 2005). Brage, et al. (2005) also found that heart rate and an ECG monitoring system were significantly correlated during treadmill walking and jogging.

As with the measure of skin conductance, it was not possible to calculate test-retest reliability of heart rate in the present study, since the six scenarios (during which heart rate readings were taken) were designed to generate differing levels of stress, and were, thus, not equivalent.

Conscientiousness and Neuroticism

Conscientiousness and neuroticism were measured via the NEO Five Factor Inventory (NEO-FFI; Costa & McCrae, 1992; See Appendix C). The NEO-FFI is a shortened version of the 240-item Revised NEO Personality Inventory (NEO PI-R). The NEO-FFI is a 60-item scale with 12 items measuring each of the five personality

dimensions (conscientiousness, neuroticism, extraversion, agreeableness, and openness to experience). The responses are measured on a 5-point Likert-type scale ranging from 1 = strongly disagree to 5 = strongly agree. Costa and McCrae (1992) reported a correlation of .90 between the long version and the short version of the NEO. The internal consistencies for the conscientiousness and neuroticism scales of the NEO-FFI, measured using the alpha coefficients, were .83 and .79, respectively (Costa & McCrae, 1992). In the present study, the coefficient alphas for both the personality measures, conscientiousness and neuroticism ($\alpha = .82$ and $\alpha = .77$, respectively), were very similar to those cited in previous literature (cf. Costa & McCrae, 1992).

Each item in the conscientiousness and neuroticism scales is rated on a 5-point Likert type scale with 1 = strongly disagree and 5 = strongly agree. Examples items from these scales include "I strive for excellence in everything I do" (conscientiousness) and "I often feel tense and jittery" (neuroticism).

Situation Awareness Training

In order to provide situation awareness training, the Situation Awareness Training (SAT) program was custom designed (by Feruzan S. Irani in conjunction with Dr. Sharon L. Oswald, Department of Management, College of Business, Auburn University) for this project. In accordance with the content requirements mentioned in the situation awareness training hypothesis development section, this program aimed at improving situation awareness through contingency planning, communication skills, teamwork skills, and stress management (further details are provided in Table 2). This training was professionally recorded to enhance the training experience and maintain consistency in

the training material. It was approximately 3 hours and 15 minutes in length and included 4 self-assessments for the participants (assertiveness, active listening skills, communication apprehension, and Type A-B personality inventory). These self-assessments were included so as to give participants the opportunity to learn their strengths and weaknesses for future self-improvement. The training also included a 25-30 minute video-clip that illustrated the concept and dangers of groupthink (Janis, 1982a) in teams.

In the SAT program, participants were given knowledge about SA, what it means, and how to go about gaining and maintaining it, despite stressful conditions. The SAT program emphasized active contingency planning as a tool to help maintain good SA (Endsley & Robertson, 2000). Active contingency planning requires nurse practitioners to continuously plan for changes in their patients' conditions and their actions, should the predicted changes occur. Active contingency planning will enable nurse practitioners to avoid being taken by surprise while treating patients and maintain good SA, especially Level 3 SA (projection).

Additionally, the SAT program also emphasized communication and teamwork skills as helpful tools to build good SA (Salas, et al., 1995). It provided information regarding active listening skills, barriers to communication, causes and symptoms of unproductive teams, and characteristics of effective teams. It went into detail regarding effective group behavior and the dangers of groupthink. Groupthink is a concept that was identified by Janis (1982a) and refers to flawed decisions made by highly cohesive groups. It is a type of conformity in which group members withhold deviant, minority, or

unpopular views in order to appear in agreement. In the SAT, this concept and its dangers were illustrated via a short video-clip. Lastly, the SAT program, gave information on stress and coping (Endsley, 1995a). It provided helpful information to the participants about stress management techniques that they could implement in their daily lives so as to better deal with their stressful profession.

Table 2

Summary of Situation Awareness Training (SAT)

Training Components	Elements in the Training	Purpose
Situation Awareness	• What is situation awareness • Definition • Three components (perception, comprehension, and projection)	Provide participants with a better understanding of the concept of situation awareness and its importance to their chosen profession (nursing, in the case of the present study).
Active Contingency Planning	• What is active contingency planning • Positive relationship of active contingency planning with situation awareness	Provide participants with an appreciation of the importance of active contingency planning in order to maintain good situation awareness.
Communication and Teamwork	• Active listening skills, • Barriers to communication, • Causes and symptoms of unproductive teams, • Characteristics of effective teams • Group behavior and dangers of groupthink	Provide participants with tools to enhance and maintain good situation awareness through good communication and teamwork skills. Provide information regarding the drawbacks of poor communication and teamwork.
Stress Management	• What is stress • Relationship of stress with situation awareness and performance • Managing stress and stress reduction techniques	Provide participants with tools to effectively deal with stress in their professional and personal lives.

Statistical Methods

Path analysis was applied in order to analyze the hypothesized relationships among individual differences (conscientiousness and neuroticism), stress (heart rate, skin conductance, and state anxiety), and the three levels of SA (see Figure 4). Path analysis is a variation of multiple-regression analysis and consists of a family of models that depicts the influence of a set a variables on one another (Spaeth, 1975). Path analysis is considered an extension of the regression model, which can be used to test the fit of a correlation matrix with the causal model (Garson, 2004). It is used most frequently to analyze data relative to a pre-specified causal model (Stage, Carter, & Nora, 2004). Path analysis conducts a series of regressions to analyze influences on the dependent variables within the specified model. Using this type of analysis, it is possible for the initial dependent variables to serve as independent variables in later regressions within the model (Stage, et al., 2004).

The primary strength of the path analysis methodology is that it allows for the study of direct and indirect effects simultaneously with multiple independent and dependent variables. Further, it allows the researcher to use software packages, such as LISREL (Hayduk, 1996; Jöreskog & Sörbom, 1984; Stage, 1990) or AMOS (Arbuckle, 1989), to draw a set of hypothesized relationships that are then translated directly into equations needed for the analysis. During a path analysis, a regression is conducted for each of the dependent (or endogenous) variables. A correlation matrix is then reproduced from the model, and this reproduced matrix is compared with the actual observed correlation matrix in order to determine the model fit. (Stage, et al., 2004).

In the present study, the final dependent variables were the three SA variables (perception, comprehension, and projection). The intent of this study was to model the direct and indirect effects of personality and stress on these variables. The only exogenous variables in the study were the two personality variables, conscientiousness and neuroticism. The stress (heart rate, skin conductance, and state anxiety) and SA (perception, comprehension, and projection) variables were both endogenous, and stress was the mediator in the relationship between personality and SA.

CHAPTER 3

RESULTS

Manipulation Checks and Preliminary Analyses

As mentioned earlier, the study was divided into scenario blocks A and B, with three scenarios (low, medium, and high stress randomly selected and presented) in each block. The treatment group participated in block A scenarios prior to the training and block B scenarios after the training. The control group participated in both blocks prior to training, with a 10 minute break between the two blocks. Heart rate and skin conductance measures were collected continuously throughout all scenarios, while state anxiety and SA were measured at the end of each scenario, for both the treatment and control groups. Since there were very few teams (27), it was decided not to average the variables to the team level; and, therefore, the unit of analyses for the entire study is the individual.

Initially, it was decided to measure the change in heart rate and skin conductance over the six scenarios. However, a preliminary Latent Growth Model revealed that there was no growth pattern in either heart rate or skin conductance, in any of the six scenarios. Moreover, since each participant experienced physiological stress at different times during the scenario calculating delta scores for stress was also not possible. Therefore, it was decided to average these measures over each scenario, producing six measures of heart rate and six measures of skin conductance (one for each scenario).

A correlation analyses was then conducted for all study variables (conscientiousness, neuroticism, heart rate, skin conductance, state anxiety, perception, comprehension, and projection). This analysis revealed no statistically significant relationships between skin conductance and any of the other variables. Based on these results, it was decided to exclude skin conductance from further analyses.

As a manipulation check to test whether the scenarios produced the intended differing levels of stress, a preliminary path analyses was conducted to examine whether there was a significant difference in stress and SA among the scenarios within block A and within block B. This analysis revealed that there was no difference in the three scenarios within block A and in the three scenarios within block B, suggesting that the scenarios did not create the intended differing levels of stress. Based on this analysis, it was decided to treat the scenarios within each block as equal. Thus, the stress and SA variables were averaged over the three scenarios in each block, creating the following overall measures: block A average heart rate, state anxiety, perception, comprehension, and projection; and block B average heart rate, state anxiety, perception, comprehension, and projection.

An additional set of preliminary multi-group path analyses was conducted to determine if there was a difference in the stress-SA relationship between the treatment and control groups (see situation awareness training section for further details). This analysis revealed that there was no distinction between these two groups, suggesting that the training intervention did not work. Hence, it was decided to combine the data.

Descriptive Statistics

Descriptive statistics for all the variables used in the analyses (conscientiousness, neuroticism; block A average heart rate, state anxiety, perception, comprehension, and projection; and block B average heart rate, state anxiety, perception, comprehension, and projection), including means, standard deviations, correlations, and reliabilities (where applicable) are presented in Table 3. Since there was no difference between the treatment and control groups (see preliminary analyses section and situational awareness training section for further details), descriptive statistics for the combined data from these two groups are presented in Table 3 and further discussed in the following paragraphs.

Physiological and Psychological Stress

As shown in Table 3, the two measures of stress (heart rate and state anxiety) were correlated with themselves in the block A and block B scenarios. That is, heart rate in the block A scenarios was correlated with heart rate in the block B scenarios ($r = .79$, $p < .01$). Similarly, state anxiety in the block A scenarios was correlated with state anxiety in the block B scenarios ($r = .76$, $p < .01$). The table also shows a statistically significant correlation between heart rate and state anxiety, but only in the block B scenarios ($r = -.29$, $p < .01$). However, contrary to expectation, this correlation was negative, suggesting that as psychological stress (state anxiety) increased, physiological stress (heart rate) decreased, and vice versa.

Situation Awareness (SA)

Perception was statistically significantly related to comprehension in the block A ($r = -.29$, $p < .01$), as well as, the block B ($r = -.35$, $p < .01$), scenarios; but, contrary to

expectation, the relationship was negative, suggesting that as perception increased comprehension decreased. None of the other SA measures were statistically significantly correlated.

Stress and Situation Awareness

Contrary to expectation, heart rate was not correlated with any of the SA measures in either block A or block B scenarios. Moreover, state anxiety was only correlated with comprehension in the block B scenarios ($r = -.21$, $p < .05$).

Personality, Stress, and Situation Awareness

Conscientiousness was correlated with heart rate, state anxiety, and comprehension in the block A scenarios ($r = .22$, $p < .05$; $r = -.25$, $p < .05$; $r = .23$, $p < .05$, respectively). However, conscientiousness was not correlated with any of the stress or SA measures in the block B scenarios. Neuroticism was correlated with state anxiety in the block A and block B scenarios ($r = .42$, $p < .01$; $r = 45$, $p < .01$, respectively), but not to heart rate or any level of SA in either the block A or block B scenarios.

These relationships were further analyzed using path analysis and the results are discussed in the next section.

Table 3

Reliabilities, Means, Standard Deviations, and Intercorrelations for Combined Data from Treatment and Control Groups

	M	SD	1	2	3	4	5	6	7	8	9	10	11	12
1. Block A Heart Rate	93.50	12.34	--											
2. Block A State Anxiety	2.32	.53	-.19	(.92-96)										
3. Block B Heart Rate	92.33	12.35	.79**	-.16	--									
4. Block B State Anxiety	2.17	.53	-.23*	.76**	-.29**	(.92-.96)								
5. Block A Perception	69.66	22.87	.07	.06	.19	-.09	(-.09-.28)							
6. Block A Comprehension	82.61	23.94	-.04	-.06	-.08	.11	-.29**	--						
7. Block A Projection	68.35	13.86	.12	-.15	.16	-.13	-.09	.17	(.62-.80)					
8. Block B Perception	69.34	18.97	-.08	.06	-.19	.19	-.49**	.12	-.06	(-.09-.28)				
9. Block B Comprehension	85.87	20.51	-.03	-.01	-.08	-.21*	.37**	-.23*	.02	-.35**	--			
10. Block B Projection	73.84	12.90	-.04	-.08	.01	-.20	.14	.02	.23*	.05	-.04	(.62-.80)		
11. Conscientiousness	3.89	.46	.22*	-.25*	.19	-.13	-.18	.23*	.03	.09	-.15	-.01	(.82)	
12. Neuroticism	2.53	.51	-.12	.42**	-.09	.45**	-.08	.01	-.06	.02	-.07	-.09	-.14	(.77)

Note: Parentheses contain Reliability estimates, where applicable; Results are combined over the three scenarios within block A and the three scenarios within block B; N = 92

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

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

Hypotheses Tests

Hypotheses 1-9 were tested by path analysis using AMOS software (Arbuckle, 1989). Initially there were six scenarios, three in block A and three in block B. As discussed in the preliminary analyses section, it was decided to treat the scenarios as equal within block A and block B and, therefore, the stress and SA variables were averaged over the scenarios within their respective blocks. This produced four overall measures of stress (block A and block B heart rate; block A and block B state anxiety) and six overall measures of SA (block A and block B perception; block A and block B comprehension; block A and block B projection). Next, a path analysis was conducted to determine if there was a difference in the stress-SA relationship between the treatment and control groups (see situation awareness training section for further details). The results of this test suggested that there was no difference, and hence, the data from these two groups were combined.

Prior to beginning the hypotheses tests, one last path analysis, with nested models, was conducted to determine if there was a difference in the stress-SA relationship between the block A and block B scenarios. The model fit did not deteriorate significantly when the stress-SA paths were constrained to equality between the block A and block B scenarios (χ^2 difference = 15.02, p = .24). This suggested that there was no distinction in the stress-SA relationship between the block A and block B scenarios. Therefore, it was decided to combine the stress and SA data from these two blocks. However, the personality-stress and personality-SA relationships were different for the two blocks and, model fit deteriorated when these paths were constrained to equality.

Hence, these relationships were maintained as separate between the two blocks. Consequently, it was decided that, in order to be most parsimonious, all stress and SA data should be combined, irrespective of treatment or control group and block A or block B scenarios. This combined model is further illustrated in Figure 8 and the results from the path analysis are presented in Table 4.

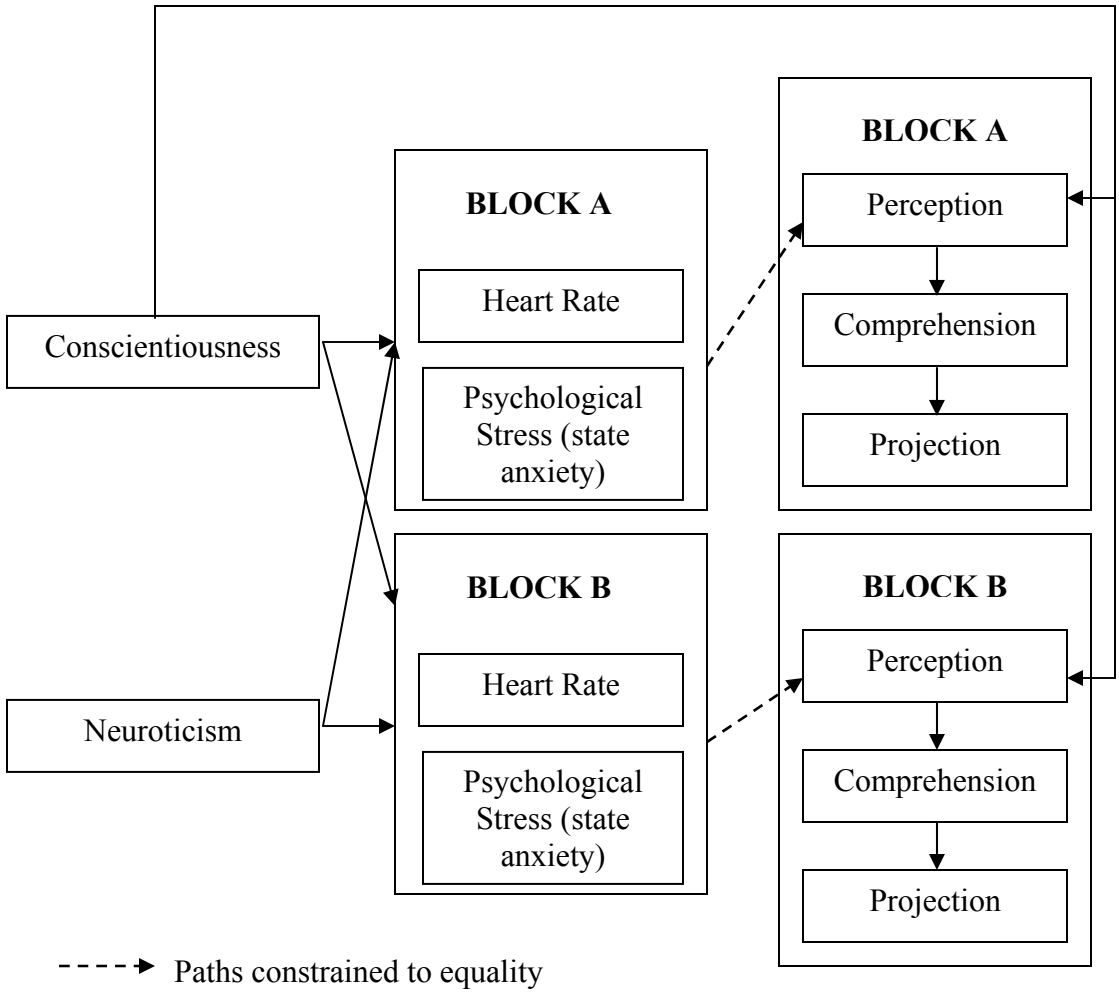


Figure 8. The final path analysis model testing the relationships among personality, stress, and the three levels of situation awareness

Table 4

Results from Path Analysis

Hypothesized direct paths	Estimated unstandardized coefficients		Estimated standardized coefficients (β)	
	Block A	Block B	Block A	Block B
Heart rate – Perception	-.05 (p = .71)	-.05 (p = .71)	-.02	-.03
State Anxiety – Perception	6.52 (p = .04)	6.52 (p = .04)	.15	.16
Conscientiousness – Heart rate	3.57 (p = .34)	2.71 (p = .49)	.14	.10
Conscientiousness – State Anxiety	-.18 (p = .27)	.01 (p = .95)	-.16	.01
Conscientiousness – Perception	-6.53 (p = .38)	5.36 (p = .43)	-.13	.11
Neuroticism – Heart rate	.22 (p = .95)	1.75 (p = .65)	.01	.07
Neuroticism – State Anxiety	.29 (p = .07)	.29 (p = .07)	.25	.26
Perception – Comprehension	-.31 (p = .00)	-.31 (p = .00)	-.26	-.30
Comprehension – Projection	.00 (p = .92)	.00 (p = .92)	.01	.01

Note: State Anxiety is a measure of psychological stress

Stress and Situation Awareness

Physiological stress. As mentioned earlier, based on preliminary analyses, it was decided to drop skin conductance from further analyses. Hence, Hypotheses 1b (inverse relationship between skin conductance and perception), 3b (inverse relationship between skin conductance and comprehension, mediated via perception), and 5b (inverse relationship between skin conductance and projection, mediated via perception and comprehension) could not be tested.

As can be seen in Table 5, the relationship between heart rate and perception (Hypothesis 1a – inverse relationship between heart rate and perception) was not statistically significant ($\beta_{block\ A} = -.02$, $p = .71$; $\beta_{block\ B} = -.03$, $p = .71$). Since this direct relationship was not statistically significant, the hypothesized relationships between heart rate and comprehension, mediated by perception (Hypothesis 3a); and heart rate and projection, mediated by perception and comprehension (Hypothesis 5a), were likewise not statistically significant. Hence, there was no support for Hypotheses 1a, 3a, and 5a.

Psychological stress. The path analyses revealed that state anxiety (psychological stress) was a statistically significant predictor for perception ($\beta_{block\ A} = .15$, $p = .04$; $\beta_{block\ B} = .16$, $p = .04$). However, contrary to the hypothesized negative relationship, state anxiety (psychological stress) had a positive relationship with perception, indicating that as perceived stress (state anxiety) increased, perception also increased, and vice versa. Therefore, Hypothesis 2 (inverse relationship between psychological stress and perception) was not supported.

Hypothesis 4 proposed an inverse relationship between psychological stress and comprehension, mediated by perception. Mediation was tested via the 4-step mediation test proposed by Baron and Kenny (1986). This 4-step method has also been used in more recent research literature (i.e., Frazier, Tix, & Barron, 2004; Walker, 2007). According to this 4-step procedure, in order to show mediation, one must show relationships between (a) the independent and mediator variables (I-M), (b) the mediator and dependent variables (M-D), (c) the independent and dependent variables (I-D), and (d) the independent-mediator-dependent variables (I-M-D). Upon establishing these relationships, full mediation will be supported if the direct path between the independent and dependent variables (I-D) is not statistically significant in the I-M-D model. Partial mediation will be supported if the I-D relationship is lower in the I-M-D model than when it is tested directly (Baron & Kenny, 1986).

These four steps, in a path analysis, can be tested via a series of nested models constraining the various paths in the mediated relationship to zero. If model fit deteriorates, this gives the indication that the constrained path was statistically significant. Hence, the mediation proposed by Hypothesis 4 (inverse relationship between psychological stress and comprehension, mediated by perception) was tested via a series of nested models constraining the various paths between state anxiety (psychological stress; I), perception (M), and comprehension (D) to zero. Assuming the default model to be true (all paths allowed to be freely estimated), when the path between state anxiety (psychological stress) and perception (I-M) was constrained to equal zero, the model fit deteriorated significantly (χ^2 difference = 9.59, p = .04), indicating the

significance of the I-M path. In the second nested model, the direct path between perception and comprehension was constrained to zero. The model fit deteriorated significantly (χ^2 difference = 19.18, p = .001), indicating that M-D path was statistically significant.

In the third nested model, the direct paths between state anxiety (psychological stress) and perception, and perception and comprehension were constrained to zero. Model fit deteriorated significantly (χ^2 difference = 28.76, p = .001), indicating that these paths were statistically significant. In order to show the significance of the I-D relationship in the absence of the mediated relationship, this path should become significant when the I-M and M-D paths are constrained to zero. However, in the present model the I-D path was statistically nonsignificant in the absence of the above mediated relationship. This nonsignificant relationship rules out the mediation of perception on the relationship between state anxiety (psychological stress) and comprehension and consequently, Hypothesis 4 was not supported.

Hypothesis 6 (inverse relationship between psychological stress and projection, mediated by perception and comprehension) was not supported due to lack of statistically significant direct relationships between perception and projection, and comprehension and projection.

Personality, Stress, and Situation Awareness

Conscientiousness. Hypothesis 7a proposed a direct negative relationship between conscientiousness and stress (physiological and psychological). Conscientiousness did not have a direct relationship with either heart rate ($\beta_{block\ A}$ = 3.57,

p = .14; $\beta_{block\ B}$ = .10, p = .49) or state anxiety ($\beta_{block\ A}$ = -.16, p = .27; $\beta_{block\ B}$ = .01, p = .95). Hence, Hypothesis 7a was not supported.

Contrary to expectation, the direct relationship between conscientiousness and perception was also not statistically significant, either in the block A or block B scenarios (β = -.13, p = .38; β = .11, p = .43, respectively). Hence, Hypothesis 7b (direct positive relationship between conscientiousness and perception) was not supported. Hypothesis 7c (positive relationship between conscientiousness and all three levels of SA, mediated by stress) was not supported due to lack of a direct relationship between conscientiousness and stress.

Neuroticism. Hypothesis 8a proposed a direct positive relationship between neuroticism and stress (physiological and psychological). The relationship between neuroticism and heart rate, though in the hypothesized positive direction, was not significant ($\beta_{block\ A}$ = .01, p = .95; $\beta_{block\ B}$ = .07, p = .65). However, neuroticism did have a slightly significant positive relationship with state anxiety ($\beta_{block\ A}$ = .25, p = .07; $\beta_{block\ B}$ = .26, p = .07)[1]. Since neuroticism was related to only one of the stress measures (psychological stress as measured by state anxiety), there was partial support for Hypothesis 8a.

Hypothesis 8b proposed that stress (physiological and psychological) will mediate the relationship between neuroticism and all three levels of SA (perception, comprehension, and projection). The mediation of heart rate on the relationship between

[1] Cautionary note: Since this relationship is only significant at the p < .10 level, any interpretations should be considered with caution.

neuroticism and the three levels of SA was not supported since there was no statistically significant direct relationship between neuroticism and heart rate.

The proposed mediation of psychological stress on the relationship between neuroticism and perception was tested using Baron and Kenny's (1986) 4-step process, as described while testing hypothesis 4. The present mediation was tested via a series of nested models constraining the various paths between neuroticism (I), state anxiety (psychological stress; M), and perception (D) to zero. Assuming the default model to be true (all paths allowed to be freely estimated), when the path between neuroticism and state anxiety (I-M) was constrained to equal zero, the model fit deteriorated significantly (χ^2 difference = 34.43, p = .001), indicating the significance of the I-M path. In the second nested model, the direct path between state anxiety (psychological stress) and perception (M-D) was constrained to zero. The model fit deteriorated significantly (χ^2 difference = 9.59, p = .04), indicating that M-D path was statistically significant.

In the third nested model, the direct paths between neuroticism and state anxiety, state anxiety and perception were constrained to zero. Model fit deteriorated significantly (χ^2 difference = 12.05, p = .09), indicating that these paths were statistically significant. However, the I-D path was statistically nonsignificant in the absence of the mediated relationship (I-M and M-D paths). This nonsignificant relationship rules out the mediation of psychological stress (state anxiety) on the relationship between neuroticism and perception.

The relationships among neuroticism and comprehension (mediated by psychological stress and perception), and neuroticism and projection (mediated by

psychological stress, perception, and comprehension) were not supported due to lack of statistically significant direct paths between neuroticism and comprehension, neuroticism and projection, and comprehension and projection. Consequently, there was no support for Hypothesis 8b.

Situation Awareness Training

As previously noted, prior to conducting hypotheses tests, preliminary analyses were used to determine if there was a difference between the treatment and control groups. In order to do this, a nested model, with constrained paths, was included in the path analysis and the deterioration of model fit was tested. The default model allowed all paths between the stress and SA variables to be estimated freely between the treatment and control groups as well as between the block A and block B scenarios.

In the nested model, these paths were constrained to equality between the treatment and control groups, but freely estimated between the block A and block B scenarios (see Figure 9 for illustration of these constraints). Assuming the default model to be correct, the model fit did not deteriorate significantly when the treatment and control groups were specified as equal (χ^2 difference = 21.65, p = .16). Hence, it seems that there was no difference in the SA-stress relationship between the treatment and control groups. Based on these result it can be concluded that the training did not diminish the negative relationship between stress (physiological and psychological) and the three levels of SA. Therefore, Hypothesis 9 (situation awareness training will diminish the negative relationship between stress and all three levels of SA) was not supported.

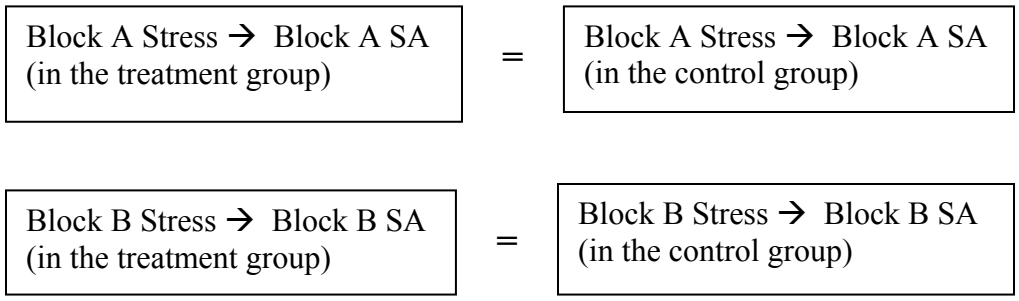


Figure 9. The constrained paths between stress and situation awareness in the treatment and control groups – nested model

Table 5 provides a written summary of the hypotheses test results.

Table 5

Results of Hypotheses Testing

Hypotheses	Supported
Hypothesis 1a. Physiological stress, as measured by heart rate, will be inversely related to Level 1 SA (perception), such that an increase in heart rate will be related to a decrease in perception.	No
Hypothesis 1b. Physiological stress, as measured by skin conductance, will be inversely related to Level 1 SA (perception), such that an increase in skin conductance will be related to a decrease in perception.	Not tested
Hypothesis 2. Psychological stress will be inversely related to Level 1 SA (perception), such that an increase in psychological stress will be related to a decrease in perception.	No
Hypothesis 3a. Physiological stress, as measured by heart rate, will be inversely related to Level 2 SA (comprehension), but this relationship will be mediated by Level 1 SA. Specifically, an increase in heart rate will be indirectly related to a decrease in comprehension through the mediation of perception.	No
Hypothesis 3b. Physiological stress, as measured by skin conductance, will be inversely related to Level 2 SA (comprehension), but this relationship will be mediated by Level 1 SA. Specifically, an increase in skin conductance will be indirectly related to a decrease in comprehension through the mediation of perception.	Not tested
Hypothesis 4. Psychological stress will be inversely related to Level 2 SA (comprehension), but this relationship will be mediated by Level 1 SA. Specifically, an increase in psychological stress will be indirectly related to a decrease in comprehension through the mediation of perception.	No
Hypothesis 5a. Physiological stress, as measured by heart rate, will be inversely related to Level 3 SA (projection), but this relationship will be mediated by Level 1 and Level 2 SA. Specifically, an increase in heart rate will be indirectly related to a decrease in projection through the mediation of perception and comprehension.	No

Hypotheses	Supported
Hypothesis 5b. Physiological stress, as measured by skin conductance, will be inversely related to Level 3 SA (projection), but this relationship will be mediated by Level 1 and Level 2 SA. Specifically, an increase in skin conductance will be indirectly related to a decrease in projection through the mediation of perception and comprehension.	Not tested
Hypothesis 6. Psychological stress will be inversely related to Level 3 SA (projection), but this relationship will be mediated by Level 1 and Level 2 SA. Specifically, an increase in psychological stress will be indirectly related to a decrease in projection through the mediation of perception and comprehension.	No
Hypothesis 7a. Conscientiousness will be negatively associated with stress (physiological and psychological), such that highly conscientious individuals will experience less stress than individuals low in conscientiousness.	No
Hypothesis 7b. Conscientiousness will be positively associated with perception, such that highly conscientious individuals will attain higher perception than individuals low in conscientiousness.	No
Hypothesis 7c. Stress (physiological and psychological) will partially mediate the positive relationship between conscientiousness and all three levels of SA, such that highly conscientious individuals will experience less stress than low conscientious individuals, which in turn will increase their SA.	No
Hypothesis 8a. Neuroticism will be positively associated with stress (physiological and psychological), such that highly neurotic individuals will experience more stress than individuals low in neuroticism.	Partially
Hypothesis 8b. Stress (physiological and psychological) will mediate the negative relationship between neuroticism and all three levels of SA, such that highly neurotic individuals will experience more stress than low neurotic individuals, which in turn will negatively affect SA.	No
Hypothesis 9. Situation awareness training will diminish the negative relationship between stress (physiological and psychological) and the three levels of situation awareness (perception, comprehension, and projection).	No

Secondary Analyses

To further explore the effect of the training on SA and stress, it was decided to aggregate the data to the group level. This step included reconsidering the possible group level effects of skin conductance that was eliminated from the individual level model. The aggregated group-level data produced overall measures for state anxiety (psychological stress), heart rate, skin conductance, perception, comprehension, projection, conscientiousness, and neuroticism for each team. A repeated measures general linear model (GLM) analyses was conducted with state anxiety, heart rate, skin conductance, perception, comprehension, and projection as the within-subjects (dependent) variables; a variable, indicating whether the team was part of the treatment group (coded 1) or the control group (coded 2) as the between-subjects factor; and conscientiousness and neuroticism as the covariates. Table 8 presents the multivariate test results of these analyses.

As can be seen in Table 6, the only three-way interaction that was statistically significant was Level×Block×Neuroticism (Wilks' $\lambda = .22$, $F(12, 11) = 3.31$, $p < .05$). This significant three-way interaction rules out all two-way interactions involving level, block, and neuroticism (such as Level×Block) and the main effects of either level or block. The only other two-way interaction that was statistically significant was Block×TC (Wilks' $\lambda = .51$, $F(6, 17) = 2.76$, $p < .05$). Univariate analyses were then conducted to further study the unique effects of these interactions on each of the dependent variables. The univariate test results of these two significant interactions are presented in Tables 7 (Block×TC) and 8 (Level×Block×Neuroticism).

Table 6

Multivariate Analyses Results

	Effect	Wilks' λ	F	Hypothesis df	p-value
Between Subjects	Intercept	.29	6.84	6	.001
	TC[a]	.61	1.83	6	.15
	Conscientiousness	.59	2.01	6	.12
	Neuroticism	.68	1.31	6	.31
Within Subjects	Level[b]	.59	.64	12	.77
	Level×TC	.54	.78	12	.66
	Level×Conscientiousness	.46	1.07	12	.46
	Level×Neuroticism	.49	.97	12	.52
	Block[c]	.44	3.65	6	.02
	Block×TC	.51	2.76	6	.047
	Block×Conscientiousness	.59	1.96	6	.13
	Block×Neuroticism	.57	2.18	6	.1
	Level×Block	.24	2.87	12	.046
	Level×Block×TC	.54	.78	12	.67
	Level×Block×Conscientiousness	.41	1.33	12	.32
	Level×Block×Neuroticism	.22	3.31	12	.03

[a] TC is coded such that TC 1 = treatment group and TC 2 = control group
[b] Level is coded such that Level 1 = low stress scenarios; Level 2 = medium stress scenarios; and Level 3 = high stress scenarios
[c] Block is coded such that Block 1 = block A scenarios and Block 2 = block B scenarios

Table 7

Univariate Analyses Results for Block×TC Interaction

Source	Measure	F[a]	p-value	Partial η^2
Block[b]×TC[c]	State Anxiety	2.95	.10	.12
	Heart Rate	2.15	.16	.09
	Skin Conductance	13.09	.002	.37
	Perception	2.78	.11	.11
	Comprehension	4.95	.04	.18
	Projection	.07	.79	.003

[a] df = 1
[b] Block is coded such that Block 1 = block A scenarios and Block 2 = block B scenarios
[c] TC is coded such that TC 1 = treatment group and TC 2 = control group

Table 8

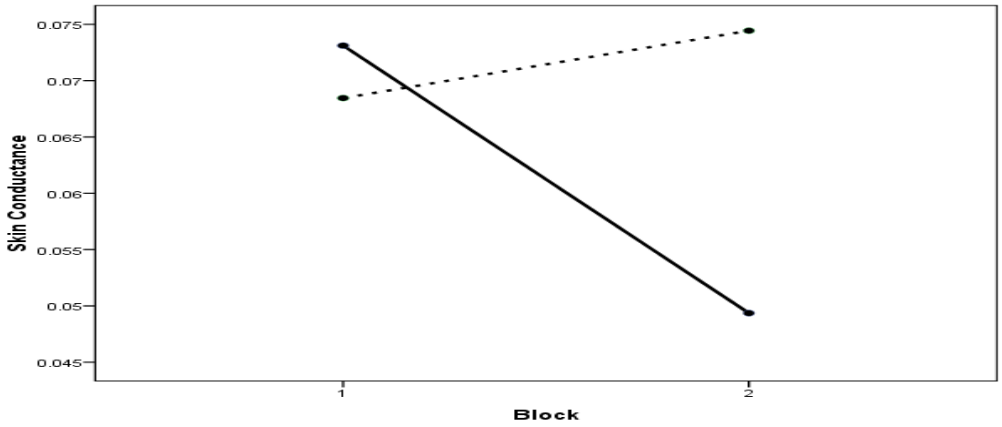
Univariate Analyses Results for Level×Block×Neuroticism Interaction

Source	Measure	F[a]	p-value	Partial η^2
Level[b]×Block[c]×Neuroticism	State Anxiety	7.26	.002	.25
	Heart Rate	.08	.92	.004
	Skin Conductance	1.43	.25	.06
	Perception	1.39	.26	.06
	Comprehension	1.34	.27	.06
	Projection	2.38	.11	.1

[a] df = 2
[b] Level is coded such that Level 1 = low stress scenarios; Level 2 = medium stress scenarios; and Level 3 = high stress scenarios
[c] Block is coded such that Block 1 = block A scenarios and Block 2 = block B scenarios

Block × Treatment/Control

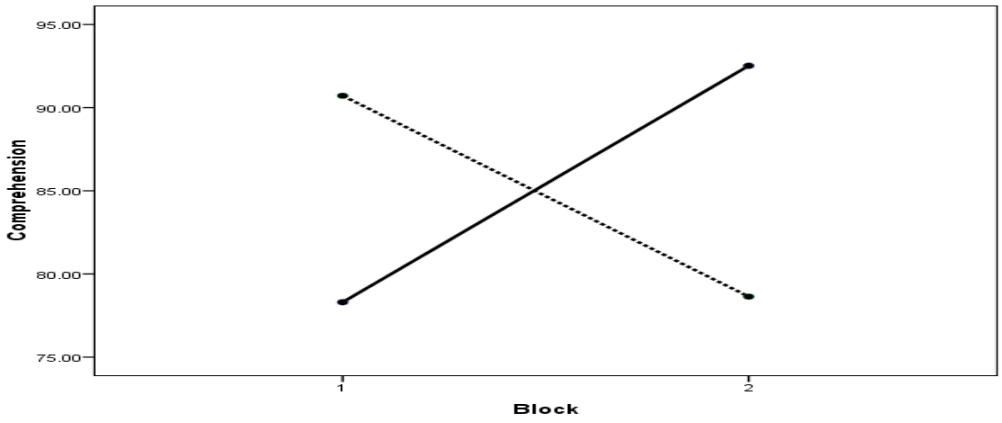
As can be seen in Table 7, the block × treatment/control interaction had statistically significant relationships with skin conductance ($F (1, 22) = 13.09$, $p < .01$, partial $\eta^2 = .37$) and comprehension ($F (1, 22) = 4.95$, $p < .05$, partial $\eta^2 = .18$). These relationships are further illustrated in the interaction plots depicted in Figures 10 and 11, respectively.



Treatment Group

Control Group

Figure 10. Plot of interactive effects of Block (1 = block A; 2 = block B) and treatment/control group on skin conductance



Treatment Group

Control Group

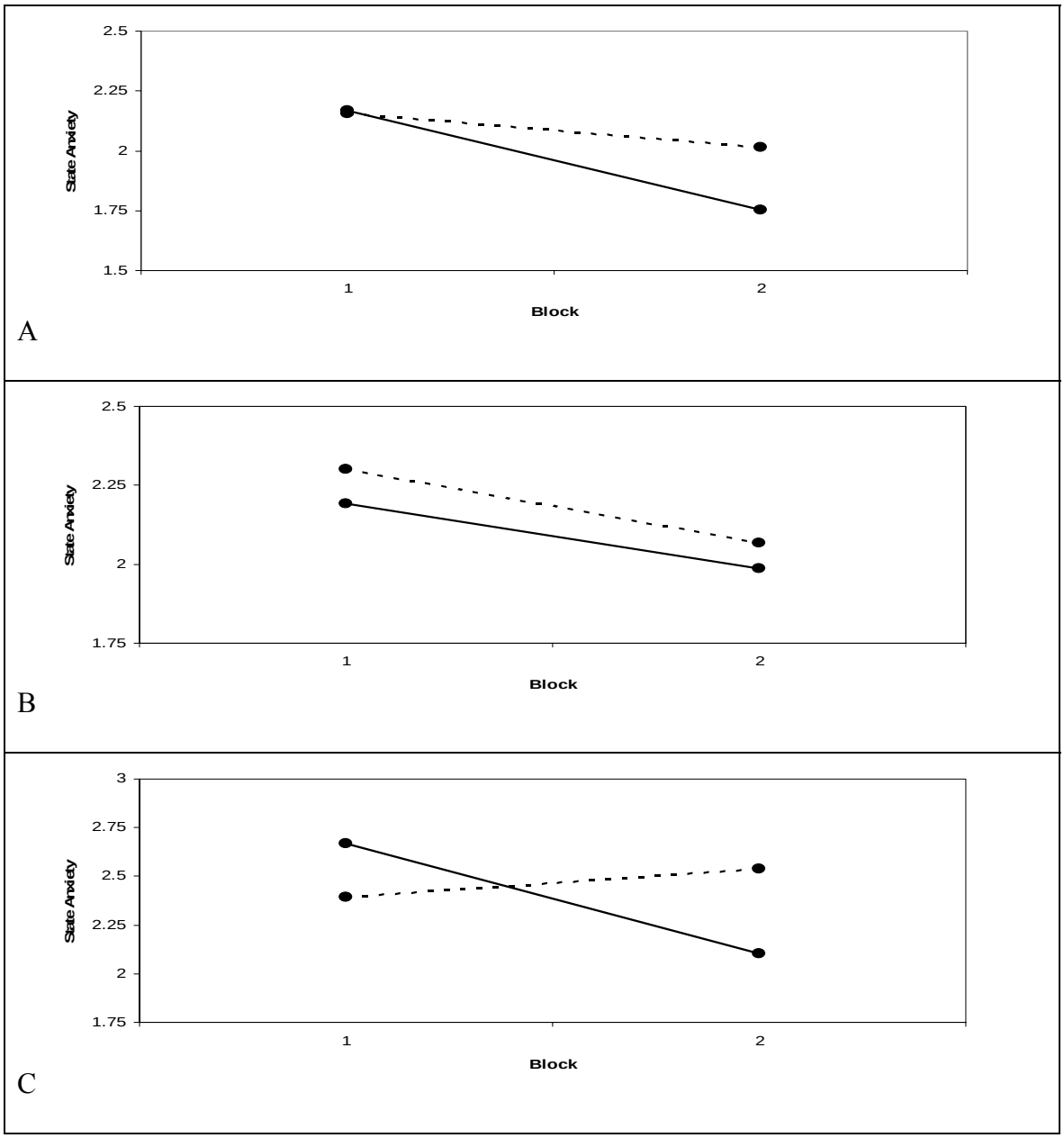
Figure 11. Plot of interactive effects of Block (1 = block A; 2 = block B) and treatment/control group on comprehension

As can be seen in Figure 10, physiological stress level (as measured by skin conductance) decreased from block A to block B in the treatment group, while it slightly increased in the control group. These results suggest that the training helped to reduce some of the physiological stress experienced by the participants. However, the training did not seem to have a statistically significant group level effect on either state anxiety or heart rate (see Table 7). Hence, the training had only a marginal effect on the stress experienced by the participants.

Figure 11 shows the interactive effects of block and treatment/control on comprehension. As illustrated, comprehension increased from block A to block B in the treatment group, while decreasing in the control group. This indicates that the training helped to increase the comprehension level of the participants. However, the training did not appear to have a statistically significant effect on either perception or projection (see Table 7). Hence, the results suggest that the training had only a marginal effect on the participants' SA.

Level × Block × Neuroticism

As can be seen in Table 8, the three-way interaction between level, block, and neuroticism only had a statistically significant relationship with state anxiety ($F(2, 44) = 7.26$, $p < .01$, partial $\eta^2 = .25$). These interactions are further illustrated in the interaction plots depicted in Figure 12.



Low Neuroticism → $M_{neuroticism}$ (2.5) – 1 $SD_{neuroticism}$ (.25)

High Neuroticism → $M_{neuroticism}$ (2.5) + 1 $SD_{neuroticism}$ (.25)

Figure 12. Plot of interactive effects of Level (plot A = low stress; plot B = medium stress; plot C = high stress), Block (1 = block A; 2 = block B), and neuroticism on state anxiety (psychological stress)

As illustrated in Figure 12, plot A, in the low stress level scenarios, the low neurotic and the high neurotic individuals had approximately the same level of state anxiety (psychological stress) in the block A scenarios, while the state anxiety (psychological stress) level decreased for the low neurotic individuals during the block B scenarios. Figure 12, plot B, shows that in the medium stress scenarios, low neurotic individuals displayed lower state anxiety (psychological stress) than high neurotic individuals during both the block A and block B scenarios; and that state anxiety (psychological stress) decreased from block A to block B for both the low and high neurotic individuals. Figure 12, plot C, illustrates that low neurotic individuals had a higher state anxiety (psychological stress) level than high neurotic individuals during block A scenarios, but lower state anxiety (psychological stress) levels in the block B scenarios. Additionally, while the low neurotic individuals demonstrated a decrease in state anxiety (psychological stress) from block A to block B, the high neurotic individuals showed a slight increase.

CHAPTER 4

DISCUSSION

The primary purpose of this dissertation was to explore the effect of individual differences and the SAT on the relationship between SA and stress. Specifically, it was hypothesized that the negative relationship between stress and SA would be affected by certain individual differences (conscientiousness and neuroticism), and that this negative relationship would be diminished by the SAT. These relationships were explored under various theories such as Situation Awareness Theory (Endsley, 1995a), Threat-Rigidity Theory (Staw, Sandelands, & Dutton, 1981), Need for Closure Theory (Kruglanski & Webster, 1996), and Theory of Stress, Appraisal, and Coping (Lazarus & Folkman, 1984).

As mentioned earlier, traditionally, the study of SA was predominantly confined to the field of aviation (Redden, 2001). However, SA has been recognized to be of vital importance to a variety of other occupations such as anesthesiology (e.g., Gaba, Howard, & Small, 1995), air traffic control (e.g., Endsley & Rodgers, 1994), large-systems operations (e.g., Wirstad, 1988), tactical and strategic systems (e.g., Klein, 1989) and infantry operations (Matthews, Strater, & Endsley, 2004). The present research examined SA in an emergency medical setting, focusing on both environmental and individual factors related to SA. Specifically, the study examined the relationships among SA, stress, and personality.

The study hypotheses were tested using data collected from nursing students engaged in six simulated medical scenarios using Laerdal's advanced patient simulator "SimMan". Demographic and personality information were collected prior to the actual simulation. During the simulation, participants were presented with medical scenarios involving different levels of stress. The treatment group participated in three scenarios (randomly selected and presented), followed by the SAT, and again followed by, the remaining three randomly ordered scenarios. The control group participated in all six scenarios (presented in a random order) prior to taking the SAT. Physiological stress data (heart rate and skin conductance) were collected throughout the six scenarios, while SA and psychological stress (state anxiety) information was collected at the end of each scenario.

This chapter discusses the findings presented in Chapter 2. The implications and limitations of the present study will also be discussed in the following paragraphs. Ideally, before proceeding with the actual study, a pilot test should have been conducted. However, in the present study, the participants needed to be at least in the junior year in the nursing programs at the two universities in order to have the required technical ability. Given that there were only 140 qualified participants available, it was decided that a pilot study would severely limit the sample size of the actual study, thus compromising the results. Therefore, a pilot study was not conducted, although the SA instruments were subjected to a content validity test to ensure soundness.

Measurement Issues and Hypothesized Relationships

Situation Awareness (SA)

According to previous theory (Endsley, 1995a) and research (Redden, 2001), perception should be positively related to comprehension, and comprehension should be positively related to projection, and these relationships should be sequential in nature. In the present study, the relationship between perception and comprehension was statistically significant, but negative; indicating that, contrary to theory, as perception increased, comprehension decreased. In addition, comprehension was not statistically significantly related to projection. The potential reasons for this lack of relationships are summarized in the following paragraphs.

Despite having good content validity, the reliabilities for the SA (perception, comprehension, and projection) instruments were very low. Internal consistency reliabilities are necessary to verify that the measured variables reflect the underlying latent attributes (Nunnally & Bernstein, 1994). "Internal consistency estimates relate to item homogeneity or the degree to which the items on a test jointly measure the same construct" (Henson, 2001, p. 177). Relative to scales with low reliability, scales with high reliability will have more statistical power (Redden, 2001). Previous literature suggests that an alpha of .70 is the lower acceptable bound for good reliability (Nunnally, 1978; Nunnally & Bernstein, 1994; Streiner, 2003). Using this framework, the reliabilities of the SA scales were not within acceptable bounds and hence, these scales were not have been good tools for measuring the participants' SA.

Previous research shows that effect size and statistical power can be negatively affected by lack of reliability (Henson, 2001; Reinhardt, 1996). As Reinhardt (1996) observed,

> Reliability is critical in detecting effects in substantive research. For example, if a dependent variable is measured such that the scores are perfectly unreliable, the effect size in the study will unavoidably be zero, and the results will not be statistically significant at any sample size, including an incredibly large one. (p. 3)

From the above, it can be surmised that low reliability of a variable will have a negative effect on the statistical significance of any of its hypothesized relationships with other variables. In the present study, the lack of reliability of the SA scales may have led to the statistical non-significance of their relationships with each other, stress, and personality. Henson (2001) mentions that the bottom-line ramifications of statistical non-significant results due to poor measurement, include "the tendency to ignore potentially meaningful effects, and a perpetuated misunderstanding of why the results were not significant" (p. 186). Consequently, the true relationships among SA, stress, and personality may have been masked, in the present model, due to the poor reliability of the SA scales.

Aside from lack of reliability, another reason, for the observed lack of relationships among SA, stress, and personality, could be that the SA data lacked variability. While the content validity ratio of the SA scales was acceptable, the SMEs may have underestimated the participants' technical knowledge and abilities and, thus,

created scenarios that were not stressful to the participants. Anecdotally, it was observed that the participants performed most tasks that the SMEs had deemed beyond their abilities.

The various problems with the SA instruments, described above, may have contaminated the results of the study; and made it impossible to test many of the hypothesized relationships among SA, stress, and personality. These problems with reliability and variability could have been avoided had the SA instrument been pre-tested via a pilot study.

Physiological and Psychological Stress

In the present study, heart rate and skin conductance were used as physiological stress measures. These measures have been used in previous studies as measures of physiological stress with varying degrees of success (e.g., Lepore, et al., 2006; Iwanaga, et. al., 2000; Cowings & Toscano, 2000; Cramer, 2003; Schaubroeck, Ganster, & Fox, 1992; Storm, Myre, et al., 2002). Since there was no conclusive evidence in the literature as to whether heart rate and skin conductance were good measures of stress, both were included in the present study. However, the results showed these measures to be minimally reactive to stress, and they were likewise not correlated with each other.

There is some evidence to suggest that other physiological measures, such as blood pressure, may be more reactive to stress situations. In fact, as noted by Fox, Dwyer, and Ganster (1993), "Heart rate…is probably neither a valid measure of stress-related arousal nor a useful predictor of morbidity" (pp. 296-297). Additionally, the absolute non-responsiveness of skin conductance may be because skin conductance is a

function of the skin's ability to conduct an electric current, which is, in turn, affected by sweat-rate. Although previous research shows that skin conductivity is affected by emotional stimuli, as well as, the sweat from physical activity (Liden, et al., 2002); the present study may not have induced enough stress to affect either the participants' sweat-rate or their heart rate.

In the previously mentioned study by Fox, et al. (1993), blood pressure and cortisol levels were used as measures of physiological stress. Although, these might be better measures of physiological stress, they were not feasible, for various reasons, in the present study. First and foremost, the ambulatory blood pressure monitors available on the market did not meet the requirements of the study. Various devices were explored, including those manufactured by SunTech Medical®, and Tiba Medical, Inc. All these ambulatory blood pressure monitors were calibrated to take blood pressure once every five minutes. Since the scenarios in this study ranged from three to five minutes, this would not guarantee a blood pressure measure during each scenario. One ambulatory blood pressure device (manufactured by Tiba) was available, that could be calibrated, via special code, to take blood pressure once every minute. However, for an accurate blood pressure reading, this device required the participant's arm be held absolutely steady. This would have compromised the integrity of the scenarios and thus, this device could not be used. Therefore, it was not feasible to use blood pressure as a measure of stress in the present study.

Other physiological stress measures, such as cortisol, require expensive laboratory testing and involve a prohibitive cost. Several expensive devices are available on the

market to self-test for cortisol, such as the one manufactured by Home Health Testing® which costs $79.95 per test. Each study participant would have required eight tests (one at the end of each of the six scenarios, and one prior to the block A and block B sections), bringing the cost to approximately $640.00 per person. The total cost of testing the change in cortisol levels, for the 93 study participants, would have been approximately $59,500.00. Thus, these measures were, also, not feasible in the present study. Consequently, the best options for physiological stress measures, in the present study, were heart rate and skin conductance.

Another problem here might lie with the length of the scenarios. The scenarios ranged from 3-5 minutes in length, which may not have been long enough to elicit either a physiological or a psychological stress response. Sherwood and Turner (1992) found 3 to 15 minutes as the typical time employed by researchers in laboratory reactivity testing to measure cardiovascular responses. While the scenarios in the present study were within that range, they were at the low end. It has also been suggested that physiological reactions to stress, especially skin conductance, may take as long as 15 to 45 minutes to appear (D. D. Wadsworth, personal communication, October 14, 2008). Due to time constraints, it was not possible to monitor the participants, for physiological reactions, for any length of time after the completion of the scenarios. This constraint may also have been one of the reasons for the non-responsiveness of the physiological stress measures.

The psychological stress measure (state anxiety) was more responsive to the stress scenarios than the physiological counterparts. The state anxiety scale had good reliability and showed statistically significant relationships with personality (discussed further in the

next section) and perception (Level 1 SA). The positive relationship between psychological stress (state anxiety) and perception (which was contrary to expectation) could be attributed to the measurement problem with the perception scale and may not have anything to do with the state anxiety scale.

Personality, Stress, and Situation Awareness

Neuroticism was hypothesized to have a positive relationship with stress because highly neurotic individuals are more likely to view stimuli as a threat, thus resulting in higher levels of stress (Nasurdin, et al., 2004). In the present study, neuroticism was only slightly related to psychological stress (see footnote 3 in the hypotheses tests section for cautionary note on this relationship), but not to physiological stress. Hence, personality may be a good predictor of whether individuals will perceive a situation as stressful, but it may not necessarily create an immediate negative physiological response. This precedence of the psychological stress response supports the stress, appraisal, and coping model (Lazarus & Folkman, 1984), which describes the intervening psychological processes between exposure to potentially stressful conditions and physiological activation. In other words, when situations are appraised as threatening, individuals are expected to react with greater negative emotion, which, in turn, leads to physiological responses that may influence the onset or progression of disease (Lazarus & Folkman, 1984). This suggests that psychological stress precedes physiological activation. However, this conclusion should be viewed with caution because physiological stress values may have been affected by the lack of responsiveness of the physiological stress equipment.

Additionally, as mentioned earlier, previous literature suggests that neuroticism may not be a good predictor of physiological stress. For example, in their study on dispositional affect and work-related stress, Schaubroeck, et al., (1992) found that neuroticism was not correlated with any of their hypothesized physiological stress outcomes (palmer sweat, diastolic blood pressure, systolic blood pressure, heart rate, skin temperature, and adrenaline). However, in the present research, it was felt that since neuroticism has been shown to be strongly related to psychological stress (e.g., Birch & Kamali, 2001; Deary & Blenkin 1996; Tellegen, 1985), this relationship would translate to a physiological reaction, if the induced stress was high enough. Therefore, neuroticism was hypothesized to have a positive relationship with physiological, as well as, psychological stress.

In accordance with previous theory and research, conscientiousness was hypothesized to have a negative relationship with stress because conscientious individuals tend to have positive feelings of personal achievement, successfully deal with stress by utilizing problem-solving coping strategies, and apply themselves to solving the practical aspects of a stressor (Deary & Blenkin, 1996; Penley & Tomaka, 2002). However, contrary to expectation, conscientiousness was not a predictor of either physiological or psychological stress. Hence, neither of the personality measures was significantly related to physiological stress. A major reason for this could be the low responsiveness of these stress measures to the stress situations.

Situation Awareness Training

The training program, called Situation Awareness Training (SAT), was custom designed (by the author in conjunction with Dr. Sharon Oswald, Department of Management, Auburn University) and geared toward improving SA, contingency planning skills, communication skills, teamwork skills, and stress management. As mentioned earlier, the treatment group participated in three scenarios (block A scenarios), then sat through the SAT, and then participated in the remaining three scenarios (block B scenarios). The control group did all six scenarios (block A and block B scenarios) prior to the SAT. It was expected that, in comparing the two groups, the relationships among stress and all three levels of SA would diminish as a result of the training. However, in the present study there was no change between the control and treatment groups, suggesting that the training did not have any significant effect. One explanation for the lack of change may be the contamination of the SA measures and/or the non-responsiveness of the stress measures. Additionally, it is felt, that a majority of the advocated methods in the training, such as improving situation awareness, contingency planning, communication skills, teamwork skills, and stress management, require practice to be successful. Hence, the effect of the training may not have been immediately evident, especially since the post-training scenarios were conducted and the measures were taken immediately after the training (within about half to one hour).

However, in spite of the fact that training did not have the expected effect on the SA-stress relationship, the secondary analyses showed that training had statistically significant effects (at the group level) on one of the physiological stress reactions (skin

conductance) and one of the levels of SA (comprehension). These relationships, although not hypothesized, suggest that the training did demonstrate some positive effects on SA and stress; and these relationships should be further studied in future research.

Limitations and Future Research

Limitations

As mentioned earlier, the unreliability of the SA scales and the non-responsiveness of the stress measures likely contaminated the results of the study. Hence, a major limitation may be the absence of validated SA measures. Before the model proposed in this study, or any of its components, are discarded, further analyses should be performed using new or refined SA and stress instruments. For example, different measures of physiological stress, such as blood pressure and/or cortisol (e.g., Fox, et al., 1993), may yield more significant results than those obtained using heart rate and skin conductance. Similarly, as mentioned in the discussion section, utilizing a better SA scale, which actually probes the SA requirements of the participants, may go a long way in changing the results of this study.

Another limitation of this study was the sample size. The unreliability of the SA scales and the non-responsiveness of the stress measures could have been diagnosed prior to the actual data collection by conducting a pilot test. However, as mentioned earlier, the available qualified sample size was too small to permit a pilot test. Additionally, path analysis is subject to the usual assumptions that are inherent in regression. One of the main requirements is to have an adequate sample size. In the present study, data was available from only 92 participants (one participant had to be dropped from the study due

to incomplete data). According to Kline (2005), "a desirable goal is to have the ratio of the number of cases to the number of free parameters be 20:1; a 10:1 ratio, however maybe a more realistic target" (p. 111). Because the present study required sample subjects in a specific curriculum with an already established knowledge base, additional participants were not available, and therefore, the effective sample size was quite small. Hence, the results from this study should be viewed with caution because "in general, the accuracy and stability of a path analysis declines with decreasing sample size…" (Stage, et al., 2004, p. 6).

Additionally, students were used to collect data to test the study hypotheses. This may limit generalizations of the study findings to actual medical professionals. Previous research suggests that students may not be good proxies for practicing professionals. For example, Oswald (1991), compared arbitral decisions made by students and practicing arbitrators and found a significant difference between the two groups. Her research suggested that students were not good substitutes for professional groups in behavioral research. Hence, in future research, the study model should be tested using data collected from actual medical professionals, before any assumptions about the usefulness of the developed training program are made.

Generalizability of this study could also be affected by the fact that the study was entirely based on emergent medical situations. People in other high-intensity occupations, performing other kinds of tasks, may require different skills. Moreover, a majority of the participants in the study were female and Caucasian, further negatively affecting generalizability.

Future Research

Future research should concentrate on improving the SA scale by employing SMEs that have a better conception of the potential participants' technical knowledge and abilities. These scales should then be pilot tested to ensure their effectiveness and reliability, before using them to actually test the proposed model. Similarly, better measures of physiological stress, such as blood pressure, should be employed and pilot tested prior to the actual study. These steps will ensure that the future study does not encounter the same measurement problems as the present study.

Another area for future research involves conducting the study in an actual medical facility, using medical professionals rather than students. The present study could be strengthened by using medical professionals practicing at multiple facilities. The latter would help to alleviate common source bias. Future studies should also ensure a large enough sample size in order to test the proposed model. As mentioned earlier, an appropriate sample size for the present study would have been at least 160 participants. Additionally, the study scenarios should be lengthened in order to elicit maximum stress response from the participants; and the post-training data should not be collected until sufficient time has elapsed to allow participants to assimilate and practice the recommendations of the training.

In future research, the proposed model could also be tested in a non-medical setting, as none of the model components are specific to the medical field. This can be done by using other stress-inducing tasks instead of the emergent medical scenarios used in the present study. Previous research on stress and its antecedents and consequences

has used a variety of stress-inducing tasks such as video games (e.g., Turner & Carroll, 1985), mental arithmetic (e.g., Turner & Carroll, 1985), Reaction Time tasks (e.g., Light, 1983), Stroop color-word tests (e.g., Manuk & Proietti, 1982), and Raven's matrices (e.g., Steptoe, Melville, & Ross, 1983). For example, a computer program could be developed whereby participants (including students) are required to play a high-stress video game and at random times the game could be automatically paused and the computer can pose a question regarding what was on the screen just prior to the pause (SA questions). In this way, the SA test can be completely computerized and be truly random.

Lastly, personality traits, other than the Big Five (Costa & McCrae, 1992), such as perfectionism (Frost, Marten, Lahart, & Rosenblate, 1990; Hewitt & Flett, 1991), might have been better predictors of stress and SA. For example, the self-oriented perfectionism subscale of the Multidimensional Perfectionism Scale (Hewitt & Flett, 1991) measures the tendency to set unrealistic standards for oneself and to focus attention on one's flaws and failures in performance. Individuals with a strong tendency toward perfectionism would tend to experience more anxiety and stress than those individuals low on perfectionism. Previous research has found strong associations between perfectionism and psychological distress among medical, dental, nursing, and pharmacy students (Henning, Ey, & Shaw, 1998). Hence, perfectionism could be a useful predictor of stress and SA.

Concluding Remarks

The fast pace of society today has made its way into the workplace. The business world places a great deal of emphasis on ones ability to cope with ever-changing environments and being able to make split-second critical decisions based on considerable information coming from numerous sources. To be effective in such an environment, one must be situationally mindful at all times. Generating and maintaining good SA is paramount to making appropriate decisions in critical situations (Endsley, 1999; Klein, 2000). Further, it is essential for effective functioning in complex and dynamic situations and has been closely linked to human decision-making and performance (Endsley & Garland, 2000; Matthews, et al., 2004). Therefore, the study of SA, along with its antecedents and consequences, is crucial to the success and well-being of workers in today's fast paced business.

The model proposed in the present study goes a long way in explaining the relationships among SA and its antecedents. There is still a lot to learn about these relationships and plenty of opportunities for future research.

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APPENDICES

APPENDIX A

SITUATION AWARENESS SCENARIOS AND QUESTIONNAIRES

SITUATION AWARENESS SCENARIOS AND QUESTIONNAIRES

(Scoring: for every right + 1; for every wrong – 1)

The participants will be told in advance that they can use the phone in the room to call physicians, code, etc., and also that they can verbalize what they need information on like lab values etc. and we will provide the information.

The background information will be verbally told to the participants and will also be available to them in a handout.

Scenario A: Managing Nausea

Type: Routine Low Stress 1

Background Information: Time: 09:00 a.m.

Doris Bowman is a 39-year-old female patient who has undergone a total abdominal hysterectomy with bilateral salpingoopherectomy under general anesthesia and is now in the recovery room. Patient tolerated the procedure without complications. She has an abdominal incision covered with a 4x4 gauze dressing and no drainage. She has received a total of 2 liter LR during surgery. The second liter of LR is still infusing at 125 mL/hr. The estimated blood loss is 400 mL. She was extubated in the operating room and is breathing spontaneously at 10 breaths per minute. She has a Foley catheter placed with 200 mL urine output. She has received 5mg Morphine IV just before leaving the operating room. Just to reiterate, Ms. Bowman is in the recovery room at present.

Clinical signs immediately visible:

- Pale
- Response to name
- Moves extremities on command
- Moaning

Additional Information, Medical History

Patient data:	Female – Age 39 years. Weight 132 pounds (60 kg). Height 66 inches (1.67 meters)
DOB:	2/10/1967
MR#:	PCS21000
Allergies:	None

Prior medical history: No significant history. She takes no medication other than iron that her physician has recently ordered for anemia related to her menorrhagia.

Recent medical history: Patient has been experiencing painful and heavy periods, pelvic "pressure", bloating, and fatigue. She also mentions urinary frequency and some shortness of breath with exertion. All of these symptoms began gradually and have been getting worse over the last several months. She was seen by her gynecologist at which time a diagnosis of fibroid uterus with resultant dysmenorrheal and menorrhagia was made. Following a CBC and Hgb of 8 g/dL she was also diagnosed with anemia and placed on iron tablets.

Scenario A Script

Time Elapsed	Monitor Settings (Actions)	Patient/Manikin (Actions)	Participant Interventions (Events)	Information Available/Provided to Participants
+ 1-2 Minute	**Oxygen trend:** Oxygen tubing will be attached to flow meter 2 L/min: SpO2 > 98% **Pain trend:** awRR: > to 12 HR: > to 94 BP: > to 130/88 Temp: 98.6 F	**Vocal sounds:** Patient more alert asking, "Where am I, is surgery over? My stomach hurts." "I think the level is 4-5." "I am feeling terrible pain in my stomach."	Assess pain level 1-10 Review Physician's Orders	IV will be attached No orders provided for pain
+ 2-5 Minutes		**Vocal Sounds:** Patient "I feel really sick to my stomach, I think I am going to throw up."	Turn patient to side and provide emesis basin. Review Physician Orders. Call Physician for orders to administer antiemetic.	No orders for an antiemetic.
Stopping Point	HR and BP will be high at end of scenario.			Stop right after receiving orders on the phone from Physician for antiemetic (Phenergan 25mg IV push every 6 hours for Nausea and Morphine 2 mg IV for the pain) and participant receiving order has a few seconds to convey it to the rest of the team and get the medication from the cart.

Situation Awareness Questions (Scenario A):

Perception:

1. What is your patient's name?
   a. Dianna Boone
   b. **Doris Bowman**
   c. Dennis Bateman

2. Did your patient have normal vital signs through out the scenario?
   a. **Yes**
   b. No

3. Where was your patient situated during the scenario?
   a. ICU
   b. **Recovery room**
   c. Emergency Department

4. What procedure did your patient recently undergo?
   a. Routine check-up
   b. **Abdominal hysterectomy**
   c. Cholecystectomy

5. Does your patient have any recorded allergies?
   a. Yes
   b. **No**

6. Were there initial orders from the Physician to treat your patient's pain and nausea?
   a. Yes
   b. **No, had to call Physician for orders**

7. What orders did you receive from the Physician?
   a. Reglan 10 mg IV push
   b. **Phenergan 25mg and Morphine 2 mg**
   c. Zofran 20 mg IV push

Comprehension:

1. Your patient is likely suffering from:
   a. Post-operative bleeding
   b. **Side-effects of Anesthesia**
   c. Post-operative infection

Projection:

1. In order to ease your patient's complaints you must: (circle all that apply)

a. Check vital signs
b. **Turn patient to side**
c. **Provide emetic basin**
d. Check abdominal dressing
e. **Review Physician's Orders**
f. **Call Physician for Orders, if they don't already exist**
g. **Administer anti-emetic as ordered by Physician**
h. Check SpO2
i. **Assess nausea**
j. **Assess effects of medication**

Scenario B: Preventing Respiratory Complications

Type: Routine Low Stress 2

Background Information: Time: 07:00 a.m.

Verna Watkins is a 69-year-old Caucasian female who had an emergency hemicolectomy for a perforated colon 3 days ago. She has a midline abdominal incision. She has a right forearm peripheral IV of LR. IVPB of Ancef was started at 06:45 a.m. and she has received her Hydrochlorothiazide tablets. Her nasogastric tube and Foley catheter were removed this morning. She is tolerating full liquids and voiding without difficulty. She was medicated with 2 Percocet tablets for pain at 6:00 a.m. The pain was rated as a "6" on a pain scale.

Clinical signs immediately visible:

- Alert and responsive
- Expressing pain
- Appears uncomfortable

Additional Information, Medical History

Patient data:	Female – Age 69 years. Weight 176 pounds (80 kg). Height 72 inches (1.82 meters)
DOB:	3/15/1939
MR#:	PCS40900
Allergies:	Penicillin (hives)
Prior medical history:	Ms. Watkins is a retired postal service worker. She has a history of cataracts, controlled hypertension. She smokes a ½ pack of filtered cigarettes a day, walks three miles a day and enjoys doing yard work.
Recent medical history:	Presented to Emergency Department 3 days ago with complaints of nausea, vomiting, and severe abdominal pain. She was admitted for emergent surgery for bowel perforation.

Scenario B Script

Time Elapsed	Monitor Settings (Actions)	Patient/Manikin (Actions)	Participant Interventions (Events)	Information Available/Provided to Participants
+ 1-2 Minute	**Initial State:** awRR: 20 HR: 85 BP: 118/74 SpO2: 92% Temp: 99.0 F	**Vocal sounds:** Patient short of breath: "I am OK but my stomach is sore and I am hungry." "It feels better now than early this morning, I would say about a 3."	Assess pain level 1-10	**Auscultation sounds:** Crackles bilaterally Hypoactive bowel sounds
+ 2-5 Minutes	HR and RR increase (within normal limits) while SpO2 decreases (not within normal limits)	**Vocal sounds (panting a little):** "You know what, I don't feel like I can get a good breath this morning! I feel so tired" **If participants ask about pain in chest:** "no my chest does not hurt, only my stomach hurts a little"	Reposition patient to provide comfort. Apply oxygen by nasal cannula. Encourage deep breathing and coughing. Encourage use of incentive spirometer.	
Stopping Point				Stop right after they address the incentive spirometer.

Situation Awareness Questions (Scenario B):

Perception:

1. What is your patient's name?
   a. Vane West
   b. Vista Watters
   c. **Verna Watkins**

2. Were your patient's blood pressure and heart rate within normal limits through out the scenario?
   a. **Yes**
   b. No

3. Was your patient's SpO2 within normal limits at the end of the scenario?
   a. Yes
   b. **No**

4. What procedure did your patient recently undergo?
   a. Routine check-up
   b. **Hemicolectomy**
   c. Appendectomy

5. Does your patient have any recorded allergies?
   a. **Yes**
   b. No

6. Was an incentive spirometer provided to your patient?
   a. **Yes**
   b. No

7. Had your patient made use of the incentive spirometer?
   a. Yes
   b. **No**

Comprehension:

1. Your patient is likely suffering from:
   a. Pulmonary embolism
   b. Congestive heart failure
   c. **Fluid build up in the lungs**

Projection:

1. In order to ease your patient's complaints you must: (circle all that apply)

a. **Reposition patient**
b. Auscultate heart sounds
c. **Ask patient if they have been deep breathing and coughing**
d. **Ask patient if they know how to use the incentive spirometer**
e. Check Homan's sign
f. **Ask patient if they have used the incentive spirometer**
g. **Teach patient and family splinting incision to deep breath and cough**
h. **Apply oxygen by nasal cannula**
i. **Teach patient and family how to use the incentive spirometer**

Scenario C: Opioid Intoxication

Type: Medium Stress 1

Background Information: Time: 09:00 a.m.

Doris Bowman is a 39-year-old female patient who has undergone a total abdominal hysterectomy with bilateral salpingoopherectomy under general anesthesia. Patient tolerated the procedure without complications. She has an abdominal incision covered with a 4x4 gauze dressing and no drainage. IV of LR infusing at 125 mL/hr. She received a total of 2 Liter of LR during surgery. The second liter of LR is still infusing at 125 mL/hr. Estimated blood loss was 400 mL. She was extubated in the operating room and is breathing spontaneously at 12 breaths per minute. BP stable at 124/84. She has a Foley catheter placed with 200 mL urine output. 15 mg Morphine was given 10-15 minutes ago when she complained of pain as 10 on the pain scale. She has just been transferred to the surgical unit from the recovery room.

Clinical signs immediately visible:

- Pale
- Response to name
- Moves extremities on command
- Moaning

Additional Information, Medical History

Patient data:	Female – Age 39 years. Weight 132 pounds (60 kg). Height 66 inches (1.67 meters)
DOB:	2/10/1967
MR#:	PCS21000
Allergies:	None
Prior medical history:	No significant history. She takes no medication other than iron that her physician has recently ordered for anemia related to her menorrhagia.
Recent medical history:	Patient has been experiencing painful and heavy periods, pelvic "pressure", bloating, and fatigue. She also mentions urinary frequency and some shortness of breath with exertion. All of these symptoms began gradually and have been getting worse over the last several months. She was seen by her gynecologist at which time a diagnosis of fibroid uterus with resultant dysmenorrheal and menorrhagia was made. Following a CBC and Hgb of 8 g/dL she was also diagnosed with anemia and placed on iron tablets.

Scenario C Script

Time Elapsed	Monitor Settings (Actions)	Patient/Manikin (Actions)	Participant Interventions (Events)	Information Available/Provided to Participants
+ 1 Minute	**Initial state:** awRR: 12 HR: 92 BP: 124/84 SpO2: 93% Temp: 98.4 F	**Vocal sounds** (drunk sounding): "I am doing fine…earlier I was in terrible pain but they gave me a miracle drug and now I feel GOODDDD ☺ pain is now at a 2, I think…just a little woozy and everything is spinning…"		ECG and SpO2 monitors are already attached. **Auscultation Sounds:** Hypoactive bowel sounds. Clear breath sounds.
+ 1-5 Minutes	**Opioid trend:** awRR: < to 5 HR: < to 88 BP: < to 120/80 SpO2: < to 82% Temp: 98.6 F **Alarm will sound when RR depresses**	**Vocal Sounds:** Following pain medication, patient becomes unresponsive.	Recognize respiratory depression. Begin bag-mask ventilation with 100% O2. Call Physician immediately.	Physician will give orders for Narcan 0.2 mg IV every 2-3 minutes until response obtained. If they call code team, then they will be told that it is on its way and to go deal with the patient in the mean time.
Stopping Point				Stop right after O2 has been administered, orders are received on the phone from Physician for Narcan and participant receiving order has a few seconds to convey it to the rest of the team. The scenario should be stopped after the med is prepared but before the administration of Narcan. If code team called, then the participants will be given a couple of minutes to deal with the patient and stress out before the stop.

Situation Awareness Questions (Scenario C):

Perception:

1. What is your patient's name?
   a. Dianna Boone
   b. **Doris Bowman**
   c. Dennis Bateman

2. Was there a change in your patient's RR during the scenario?
   a. **Yes, it decreased**
   b. Yes, it increased
   c. No, there was no change in RR

3. Was there a change in your patient's SpO2 during the scenario?
   a. **Yes, it decreased**
   b. Yes, it increased
   c. No, there was no change in SpO2

4. Where was your patient situated during the scenario?
   a. ICU
   b. Recovery room
   c. **Surgical unit**

5. What procedure did your patient recently undergo?
   a. Routine check-up
   b. **Abdominal hysterectomy**
   c. Cholecystectomy

6. Does your patient have any recorded allergies?
   a. Yes
   b. **No**

7. What was your patient's level of consciousness at the end of the scenario?
   a. Patient was sleepy
   b. Patient was alert
   c. **Patient was unresponsive**

Comprehension:

1. Your patient is likely suffering from:
   a. Side-effects of Surgery
   b. Side-effects of Anesthesia
   c. **A reaction to the pain medication**

Projection:

1. In order to ease your patient's complaints you must: (circle all that apply)

a. Increase rate of IV fluids
b. **Bag-mask ventilation with 100% O2**
c. **Call a Physician, if no standing orders present**
d. **Check standing orders for medication**
e. **Call a code**
f. **Administer medication as per dose recommended by Physician**
g. **Reassess vital signs and level of consciousness**

Scenario D: Moderate Allergic Reaction to Ancef

Type: Medium Stress 2

Background Information: Time: 11:00 a.m.

Karla Bronson is a 50-year-old female who presented to the Emergency Department with lower abdominal pain, fever, and flank pain. Her temperature was 102.4 degrees on admission. Physician has ordered Ancef 1g IVPB that was started 10-15 minutes ago. Patient denies any history of allergies to medication or foods. So to reiterate, the patient is in the Emergency Department at present.

Clinical signs immediately visible:

- Alert and responsive
- Calmly awaiting expected Penicillin injection

Additional Information, Medical History

Patient data:	Female – Age 50 years. Weight 132 pounds (60 kg). Height 66 inches (1.67 meters)
DOB:	10/5/XX
MR#:	PCS10500
Prior medical history:	Generally healthy. She is a school teacher. She smokes 2 packs of cigarettes per day.
Recent medical history:	She has been complaining of general symptoms of mild flank and abdominal pain and a low grade fever that has been getting worse over the past few days.

Scenario D Script

Time Elapsed	Monitor Settings (Actions)	Patient/Manikin (Actions)	Participant Interventions (Events)	Information Available/Provided to Participants
+ 1 Minute	**Initial State:** awRR: 14 HR: 80 BP: 124/72 SpO2: 98% Temp: 100.5 F	**Auscultation sounds:** Breath sounds clear bilaterally. Peripheral pulses strong bilaterally **Vocal sounds:** "My back has been hurting and I have been running a slight fever for several days and I didn't think much of it…then it got so bad this morning that I just had to come to the ER	Auscultate lungs	SpO2 and ECG monitor already applied
+ 1-5 Minutes	**Moderate allergic response trend:** awRR: > to 22 HR: > to 88 BP: > to 130/80 SpO2: < to 90% Over 3 minutes **Alarm will sound when SpO2 decreases**	**Vocal sounds:** "You know, I'm feeling kinda warm and itchy on my chest and my tongue feels kinda weird, like its swollen or something. everything just feels BIG. I think something is wrong. please help me"	**Prioritize care:** Observe skin for urticaria Monitor airway Administer O2 Assess vital signs Stop Ancef Call for help	There are no orders from Physician. When called, Physician will order: Epinephrine 1:1000 0.3 ml IV every 10-15 minutes Benadryl 50mg IV
Stopping Point				Stop right after O2 has been administered, orders are received on the phone from Physician for Epinephrine and Benadryl and participant receiving order has a few seconds to convey it to the rest of the team. The scenario should be stopped after the meds are prepared but before the administration. If code team called, then the participants will be given a couple of minutes to deal with the patient and stress out before the stop.

Situation Awareness Questions (Scenario D):

Perception:

1. What is your patient's name?
   a. Keisha Braden
   b. Kenneth Brandon
   c. **Karla Bronson**

2. Was there a change in your patient's RR during the scenario?
   a. Yes, it decreased
   b. **Yes, it increased**
   c. No, there was no change in the patient's respiration rate

3. Was there a change in your patient's SpO2 during the scenario?
   a. **Yes, it decreased**
   b. Yes, it increased
   c. No, there was no change

4. What complaints did your patient initially present with?
   a. Shortness of breath
   b. **Fever, flank and abdominal pain**
   c. Difficulty breathing

5. Does your patient have any recorded allergies?
   a. Yes
   b. **No**

6. Did your patient have any complaints during the scenario?
   a. **Yes**
   b. No

7. What were your patient's complaints during the scenario? (circle all that apply)
   a. **Patient complained that chest felt warm and itchy**
   b. Patient felt nauseous
   c. **Patient complained that her tongue felt "weird" and swollen**
   d. Patient felt much better and did not have any complaints during the scenario

Comprehension:

1. Your patient is likely suffering from:
   a. Worsening kidney infection
   b. **Allergic reaction to Ancef**
   c. Internal gastric injury

Projection:

1. In order to ease your patient's complaints you must: (circle all that apply)
   a. **Observe skin for urticaria**
   b. **Monitor airway**
   c. **Administer O2**
   d. Do abdominal assessment to check for bleeding
   e. **Reassess vital signs**
   f. **Call for help**
   g. **Stop Ancef**

Scenario E: Cardiac Arrest

Type: High Stress 1 – With irate Physician

Background Information: Time: 03:00 p.m.

Carol Shapiro is a 54-year-old female who travels frequently. She was seen in the Emergency Department at 1:30 p.m. for complaints of chest pain, diaphoresis, shortness of breath and possible Myocardial Infarction. She was treated in the Emergency Department with Aspirin and two sublingual Nitroglycerin. Chest pain improved with Nitroglycerin administration. IV was started in the Emergency Department and is infusing at 100 mL/hour. Ordered lab values are pending. Physician wants to be called as soon as the labs are available. Patient is receiving oxygen at 4 L/min. Chest pain was last rated as a "0" following 2nd Nitroglycerin. She has been admitted to the Telemetry Unit.

Clinical signs immediately visible:

- Alert and responsive
- Does not appear to be in any acute distress

Additional Information, Medical History

Patient data:	Female – Age 54 years. Weight 242 pounds (110 kg). Height 69 inches (1.75 meters)
DOB:	03/25/1954
MR#:	PCS71900
Prior medical history:	Has a history of hypertension. She states she takes "water pills" for her blood pressure (she is not sure of the name of the pill) and has been trying to exercise and lose weight but admits it is very hard when she travels. She smokes less than ½ a pack of cigarettes a day and drinks alcohol occasionally. She describes her work as "stressful".
Recent medical history:	Recent admit from Emergency Department with chest pain, diaphoresis, and shortness of breath.

Scenario E Script

Time Elapsed	Monitor Settings (Actions)	Patient/Manikin (Actions)	Participant Interventions (Events)	Information Available/Provided to Participants
+ 1-2 Minute	**Initial State:** awRR: 24 HR: 98 BP: 132/84 SpO2: 97% Temp: 98.4 F ECG: NSR with ST elevation	**Vocal sounds** (sound frustrated)**:** "Pain is still 0, when can I get out of here? I want to go home…I have better stuff to do you know rather than being here for your entertainment!!! Are you trying to keep me here so that you can get more money out of me???"	Assess pain level 1-10	**Auscultation sounds:** Breath sounds clear bilaterally. Peripheral pulses strong. ECG monitor leads will already be attached.
+ 2-5 Minutes	**Cardiac Arrest trend:** awRR: - HR: - BP: -/- SpO2: - ECG: VF **Alarms will start ringing as soon as the patient goes into cardiac arrest.**	**Vocal Sounds** (suddenly right after my upset when alarm goes off)**:** "I don't feel well. Something is wrong!!! Do something please!!!" **Patient becomes completely unresponsive.**	Recognize VFib Check leads. Assess LOC. Call for help (code team). Place backboard. Begin positive-pressure ventilation with BVM and 100% oxygen (2 ventilations). Begin CPR (30:2).	After a minute of alarms, passing Physician will hear the alarms and come into the room to see what is happening. Upon entering and not finding the code team there (even though the participants will have called the code team) he will become very irate and begin shouting at and abusing the participants. As soon as physician says "are you completely incompetent…" the VFib will become Asystole. Phsysician will increase tirade when this happens and then scenario will be stopped.
Stopping Point	Heart rhythm will go from VFib to Asystole.			Stop right after the participants conduct an ABC assessment, get the crash cart, call the code team, start CPR, Physician comes in and shouts during which the VFib becomes Asystole.

Situation Awareness Questions (Scenario E):

Perception:

1. What is your patient's name?
   a. Chad Spears
   b. Christie Smith
   c. **Carol Shapiro**

2. Where was your patient situated during the scenario?
   a. ICU
   b. Emergency Department
   c. **Telemetry Unit**

3. What were your patient's initial complaints during admission to Emergency Department? (circle all that apply)
   a. **Chest pain**
   b. Stomach pain
   c. **Shortness of breath**
   d. **diaphoresis**

4. Were your patient's vital signs within normal limits at the beginning of the scenario?
   a. **Yes**
   b. No

5. Did your patient appear to be upset at the beginning of the scenario?
   a. **Yes**
   b. No

6. What was your patient's level of consciousness at the end of the scenario?
   a. **Patient was unresponsive**
   b. Patient was alert
   c. Patient was sleepy

Comprehension:

1. Your patient is likely suffering from:
   a. Respiratory arrest followed by cardiac arrest
   b. **Cardiac arrest followed by respiratory arrest**

Projection:

1. In order to ease your patient's complaints you must: (circle all that apply)

a. Go out to the desk and get the patient's chart
b. **Conduct an ABC assessment**
c. **Put backboard under patient, if available**
d. Apply oxygen by nasal cannula
e. **Get crash cart**
f. **Call a code**
g. **Start CPR**

Scenario F: Hypoglycemia

Type: High Stress 2 – With upset father

Background Information: Time: 05:00 p.m.

Skyla Hansen is an 18-year-old female recently (within 6 months) diagnosed with type 1 diabetes. She was brought to the Emergency Department by her friends. The friends report that she started acting "weird" while they were playing basketball. They have not eaten anything for 5 hours. Skyla told them that she felt light headed and was going to lie down on the cement. They became nervous and decided to bring her in to the Emergency Department. LR IV was started upon admission. They are still in the process of getting her history.

Clinical signs immediately visible:

- Slurred speech
- Drowsy
- Wakes with stimulus
- Diaphoretic

Additional Information, Medical History

Patient data:	Female – Age 18 years. Weight 154 pounds (70 kg). Height 72 inches (1.82 meters)
DOB:	3/11/1990
MR#:	PCS31100
Prior medical history:	Diagnosed with type 1 diabetes 6 months ago. Immunizations are current. No known drug or food allergies.
Recent medical history:	None

Scenario F Script

Time Elapsed	Monitor Settings (Actions)	Patient/Manikin (Actions)	Participant Interventions (Events)	Information Available/Provided to Participants
+ 1 Minute	**Initial State:** awRR: 22 HR: 94 BP: 112/70 SpO2: 99% Temp: 98.9 F	**Vocal sounds:** "What are you doing? Don't touch me!" Continue in this strain until father gets there and then just start moaning (just before alarms sound)…		ECG monitor leads will already be attached. **Auscultation sounds:** Breath sounds clear bilaterally.
+ 1-5 Minutes	**Change in LOC trend:** awRR: < to 8 SpO2: < to 90% Over 3 minutes **Oxygen trend:** SpO2: > to 94% over 1 minute **Image on monitor:** Fingerstick glucose: 38 **Alarm will sound when RR depresses**	**Vocal Sounds:** Will not respond vocally now just moaning. When motioned by Ms. Renfroe, quit moaning, give big sigh, and become completely unresponsive	Apply oxygen. Obtain fingerstick glucose (participants should verbalize this and the information will be provided on the monitor). Call Physician once glucose is known	Patient's father enters the room and is very upset. Initially he will concentrate on his daughter, but once the alarms sound, he will alternatively shout and abuse the nurses. Father will be instructed to increase his tirade right at the end (right after the physician has been called and the ordered medication has been verbalized and they start looking for the medication to administer it and **the daughter sighs and quits moaning**).
Stopping Point		**Vocal sounds:** The patient quits moaning and becomes completely unresponsive.		Stop right after the participants call a physician, verbalize the order and get the medication, father's tirade increases, and the patient quits moaning and becomes completely unresponsive.

Situation Awareness Questions (Scenario F):

Perception:

1. What is your patient's name?
   a. Suzie Henderson
   b. **Skyla Hansen**
   c. Stryker Haslen

2. Was there a change in your patient's SpO2 during the scenario?
   a. Yes, it increased
   b. **Yes, it decreased**
   c. No, there was no change

3. Was there a change in your patient's respiration rate during the scenario?
   a. Yes, respiration rate increased
   b. **Yes, respiration rate decreased**
   c. No, there was no change

4. Was there a change in your patient's level of consciousness after the father entered the room?
   a. Yes, level of consciousness improved
   b. **Yes, level of consciousness decreased**
   c. No, there was no change in the patient's level of consciousness

5. Where was your patient situated during the scenario?
   a. ICU
   b. **Emergency Department**
   c. Telemetry Unit

6. What was your patient's level of consciousness at the end of the scenario?
   a. Alert and responsive
   b. Moaning
   c. **Completely unresponsive**

Comprehension:

1. Your patient is likely suffering from:
   a. Hyperglycemia
   b. Diabetic ketoacidosis
   c. **Hypoglycemia**

Projection:

1. In order to ease your patient's complaints you must: (circle all that apply)

a. **Apply oxygen**
b. **Call physician**
c. Administer insulin per physician's order
d. Re-check blood glucose after administration of insulin
e. **Administer D50W per physician's order**
f. **Re-check blood glucose after administration of D50W**

APPENDIX B

STATE ANXIETY SCALE

NOTE: Spileberger, et al.'s (1983) State Anxiety scale cannot be published and is, therefore, excluded from this section. Rather, a letter detailing permission from Mind Garden, Inc. is included in its place.

PERMISSION TO USE THE STATE ANXIETY SCALE

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To whom it may concern,

This letter is to grant permission for the above named person to use the following copyright material;

Instrument: ***State-Trait Anxiety Inventory for Adults***

Authors: ***Charles D. Spielberger, in collaboration with R.L. Gorsuch, G.A. Jacobs, R. Lushene, and P.R. Vagg***

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for his/her thesis research.

Five sample items from this instrument may be reproduced for inclusion in a proposal, thesis, or dissertation.

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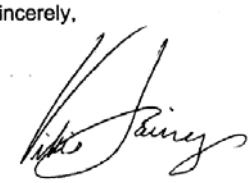
Sincerely,



Vicki Jaimez
Mind Garden, Inc.
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APPENDIX C

NEO-FIVE FACTOR INVENTORY

NEO-FIVE FACTOR INVENTORY

Directions: Please read each item below and circle the response that best represents your opinion. Go with your first response and don't spend too much time thinking. There are **NO RIGHT OR WRONG** answers, so feel free to express yourself.

1 = Strongly disagree
2 = Disagree
3 = Neutral
4 = Agree
5 = Strongly agree

Statements	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
I am not a worrier.	1	2	3	4	5
I often feel inferior to others.	1	2	3	4	5
When I'm under a great deal of stress, sometimes I feel like I'm going to pieces.	1	2	3	4	5
I rarely feel lonely or blue.	1	2	3	4	5
I often feel tense and jittery.	1	2	3	4	5
Sometimes I feel completely worthless.	1	2	3	4	5
I rarely feel fearful or anxious.	1	2	3	4	5
I often get angry at the way people treat me.	1	2	3	4	5
Too often, when things go wrong, I get discouraged and feel like giving up.	1	2	3	4	5
I am seldom sad or depressed.	1	2	3	4	5
I often feel helpless and want someone else to solve my problems.	1	2	3	4	5
At times, I have been so ashamed I just want to hide.	1	2	3	4	5
I like to have a lot of people around me.	1	2	3	4	5
I laugh easily.	1	2	3	4	5
I don't consider myself especially "light-hearted."	1	2	3	4	5
I really enjoy talking to people.	1	2	3	4	5
I like to be where the action is.	1	2	3	4	5
I usually prefer to do things alone.	1	2	3	4	5
I often feel as if I'm bursting with energy.	1	2	3	4	5
I am a cheerful, high-spirited person.	1	2	3	4	5
I am not a cheerful optimist.	1	2	3	4	5
My life is fast-paced.	1	2	3	4	5
I am a very active person.	1	2	3	4	5
I would rather go my own way than be a leader of others.	1	2	3	4	5
I don't like to waste my time daydreaming.	1	2	3	4	5
Once I find the right way to do something, I stick to it.	1	2	3	4	5
I am intrigued by the patterns I find in art and nature.	1	2	3	4	5
I believe letting students hear controversial speakers can only confuse and mislead them.	1	2	3	4	5
Poetry has little or no effect on me.	1	2	3	4	5

Statements	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
I often try new and foreign foods.	1	2	3	4	5
I seldom notice the moods or feelings that different environments produce.	1	2	3	4	5
I believe we should look to our religious authorities for decision on moral issues.	1	2	3	4	5
Sometimes when I am reading poetry or looking at a work of art, I feel a chill or wave of excitement.	1	2	3	4	5
I have little interest in speculating on the nature of the universe or the human condition.	1	2	3	4	5
I have a lot of intellectual curiosity.	1	2	3	4	5
I often enjoy playing with theories or abstract ideas.	1	2	3	4	5
I try to be courteous to everyone I meet.	1	2	3	4	5
I often get into arguments with my family and co-workers.	1	2	3	4	5
Some people think I'm selfish and egotistical.	1	2	3	4	5
I would rather cooperate with others than compete with them.	1	2	3	4	5
I tend to be cynical and skeptical of other's intentions.	1	2	3	4	5
I believe that most people will take advantage of you if you let them.	1	2	3	4	5
Most people I know like me.	1	2	3	4	5
Some people think of me as cold and calculating.	1	2	3	4	5
I'm hardheaded and tough-minded in my attitudes.	1	2	3	4	5
I generally try to be thoughtful and considerate.	1	2	3	4	5
If I don't like people, I let them know it.	1	2	3	4	5
If necessary, I am willing to manipulate people to get what I want.	1	2	3	4	5
I keep my belongings clean and neat.	1	2	3	4	5
I'm pretty good about pacing myself so as to get things done on time.	1	2	3	4	5
I am not a very methodical person.	1	2	3	4	5
I try to perform all the tasks assigned to me conscientiously.	1	2	3	4	5
I have a clear set of goals and work toward them in an orderly fashion.	1	2	3	4	5
I waste a lot of time before settling down to work.	1	2	3	4	5
I work hard to accomplish my goals.	1	2	3	4	5
When I make a commitment, I can always be counted on to follow through.	1	2	3	4	5
Sometimes, I'm not as dependable or reliable as I should be.	1	2	3	4	5
I am a productive person who always gets the job done.	1	2	3	4	5
I never seem to be able to get organized.	1	2	3	4	5
I strive for excellence in everything I do.	1	2	3	4	5

APPENDIX D

DEMOGRAPHIC QUESTIONNAIRE

DEMOGRAPHIC QUESTIONNAIRE

Dear Participant! Please take a few minutes to complete the following survey. To be useful, your responses to the items in the survey MUST BE CANDID. All responses are completely ANONYMOUS. Your opinions are valuable and we thank you for participating in the survey!

1. What is your race?
    a. Caucasian _____
    b. African-American _____
    c. Native American _____
    d. Asian/Pacific Islander _____
    e. Other (Please Specify) _____

2. What is your age? _____ year and _____ months

3. What is your gender? Male _____ Female _____

4. What is your educational status? Junior_____ Senior_____ EARN_____

5. Overall GPA: _____

6. Major (Nursing) GPA: _____