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Self-Reported Emotional States and Air Traffic Controller Operational Error Rates in Advanced Air Traffic Control Students

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SELF-REPORTED EMOTIONAL STATES AND AIR TRAFFIC CONTROLLER OPERATIONAL ERROR RATES IN ADVANCED AIR TRAFFIC CONTROL STUDENTS

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Abstract

Maintaining high safety standards is essential for the aviation industry. Reducing the rate of human error throughout the various fields of aviation is essential in order to continue to promote and mitigate aviation incidents. Air traffic controllers work in high stress environments, requiring them to make hundreds or even thousands of individual decisions in regard to aircraft positioning on a daily basis. All it takes is for one small operational error in order for an accident to occur and hundreds of lives to be lost.

Understanding potential influences upon air traffic controllers' decision making processes is crucial in order to improve upon the decisions controllers make and to further enhance aviation safety. Emotional states of mind and stress level may be an aspect to further understand decision making processes. It is well known that an individual's emotional state and current stress level can impact the quality of a decision.

This study investigates the emotional states and current perceived stress levels of advanced air traffic control students and their operational error rates. Twenty-four participants were included from a Midwestern University. Perceived stress appeared to have a relationship with operational error rates. Self-reported emotional states failed to prove significance, but increasingly positive emotional states appeared to correlate with fewer operational error rates. Future implications for research include integrating risk-taking tendencies, personality traits, and the expansion of emotional states to working group environments.

The overall relationship between emotional states and air traffic operational error

rate remains unclear, but trends appear to be present such as increasingly positive moods potentially relating to fewer operational errors. To further understand emotional states and perceived stress levels in regard to air traffic control operational error rates, more study is needed.

CHAPTER I

INTRODUCTION

"*Errare humanum est—to err is human*" stated Plutarch in 100 A.D. (Wiegmann & Shappell, 2003). The Federal Aviation Administration (FAA) estimates that seventy to eighty percent of all aviation accidents can, in part, be attributed to human error (Wiegmann & Shappell, 2003). Although there are varying definitions of human factors, the FAA defines human factors as "the multidisciplinary field devoted to optimizing human performance and reducing human error" (Advisory circular, 2004, pg. 2). The human factor component in aviation can arguably be considered one of the most unpredictable variables in the attempt of maintaining aviation safety; more specifically, air traffic controllers' most common errors relate to aircraft observation, improper usage of visual information, ground operations, and communications errors—all of which relate directly to the human component (Torres, Metscher, & Smith, 2011). Understanding how to reduce the likeliness or proneness of error in the human factor component can be a difficult task since each individual in the aviation industry is different and there is a wide array of factors involved.

One specific factor potentially contributing to human error is an individual's attitude, or more specifically, an individual's current mood or emotional state. Although attitude and mood are similar and are commonly used in reference of one another, it is important to differentiate between the two and define both terms. The Merriam-Webster Dictionary defines attitude as “a feeling or emotion towards a fact or state,” whereas mood is defined as “a conscious state of mind or predominant emotion” (Merriam-Webster, 2011). Essentially, attitudes are an overall emotion towards something or someone. Mood can be defined as specific emotional state characterizing a momentary feeling of an individual at a given point in time (Eid, Schneider, & Schwenkmezger, 1999). For the purpose of simplicity and for this study, mood, feeling, and emotion will be used interchangeably.

The current study will investigate altered emotional states and perceived stress levels and the influence they have on air traffic control performance. The study is focused on investigating if participants’ in a positive or negative emotional state has the potential for operational errors. Although difficult, the study will generalize these terms together for the purpose of simplicity—however, it is important to note that the terms are not necessarily identical.

Although the terms differ from one another, it is also important to note they are very similar since, often times, an overall positive or negative attitude may relate with positive or negative moods. Furthermore, whereas attitudes tend to last longer periods of time, moods tend to be short-lived; typically, they are also stronger experiences of emotion that tend to disappear within a matter of seconds or minutes (Andrade & Ariely, 2009). When looking at current mood states, determining whether or not a positive or negative emotional state has a relationship with air traffic control error rates is essential in order to proactively attempt to reduce human error in this aspect of the aviation industry.

Air traffic control specialists are essential to maintaining safety in aviation since their duties include ensuring “the safe, orderly, and expeditious flow of air traffic through the National Airspace System (NAS)” (Broach & Dollar, 2002, pg. 1). This is done by issuing speed, altitude, and heading instructions to aircraft in order to maintain aircraft separation safety standards (Broach & Dollar, 2002). Reducing operational errors in air traffic control specialists is an important factor to consider when maintaining aviation safety. Operational errors can be defined as failures to adhere to and maintain job duties such as appropriate aircraft separation, terrain or obstacles, or other existing hindrances (Broach & Dollar, 2002).

The United States Department of Labor Bureau of Labor Statistics estimated that in 2008, there were approximately 26,200 air traffic controllers working in the United States (U.S. Department of Labor, 2009). Currently, air traffic controllers are handling over 28 million commercial operations per year (as of 2006), and en route air traffic control centers handling over 46 million operations per year (2006) with expected growth to reach 70 million operations annually by the year 2020 (Federal aviation, 2007). It is apparent that safety among air traffic controllers needs to be upheld due to these numbers. Furthermore, a future challenge to mitigate operational errors may become a reality due to the FAA hiring 7,000 new air traffic controllers since 2005, with anticipated hiring numbers of 1,000 additional controllers per year, through 2017 (Federal aviation, 2011).

In 2005, the number of serious operational errors (defined as aircraft falling below separation minima) detected was 637 (Schroeder, Bailey, Pounds, & Manning, 2006). Currently, air traffic control facilities rely on both controller reporting and computerized conflict alert software (Schroeder et al., 2006). The software allows for warnings to be given to controllers if there is an imminent loss of aircraft separation (Schroeder et al., 2006). Also, reviewing past procedures and policies to determine which approaches have worked towards reducing operational errors is constantly occurring for future error reductions (Schroeder et al., 2006). Unfortunately, operational errors extend beyond procedural separation minimums, which is the main purpose of the conflict alert system currently in place.

There is little research on whether or not an adverse emotional state allows for air traffic controllers to become more prone to committing errors in the workplace even though a high percentage of operational errors occur during the first twenty minutes an air traffic controller is on position—perhaps due to current emotional states (Schroeder et al., 2006). However, studies have been performed comparing individual emotional states and error rates. When taking into account where an aviation professional's current mood state falls into place with error, one can examine James Reason's Swiss Cheese Model. Mood state may be one of the "holes" in the cheese, or in a chain of latent errors, that align perfectly to create an aviation incident or accident (Reason, 1990). The aviation industry strives to put defense systems in place where each "hole in the cheese" could potentially exist and cause an imminent problem (Reason, 1990; Reason, 1997; Reason, 2009). Looking more in depth at this model, Wiegmann and Shappell (2003) were able to take this model to the next level. More specifically than a simple “hole in the cheese,” the Human Factors and Analysis Classification System (HFACS) displays an adverse mental state as a condition of the operator, or a precondition for an unsafe act, which could potentially lead to an accident. Being able to classify such a potential human error is essential for improvement upon it since it allows researchers to have quantifiable data in regard to this issue.

When examining mood in air traffic controllers, it is difficult to state that moods are directly correlated with the number of operational errors committed. Therefore, for the purpose of this research, mood must be considered in regard to the overall decision making process which, in turn, leads to air traffic controller errors. By providing the necessary resources to identify and eliminate error-likely situations, managers can have the capabilities to improve upon them and drastically reduce the frequency of human errors (Rooney, 2011)

Research Questions

1. Is there a relationship between self-reported emotional state and air traffic control error rate in advanced air traffic control students?
2. Do error rates differ between participants with positive and negative reported emotional states?
3. Does a relationship exist between participant perceived stress levels and air traffic controller error rates?

4. Do overall emotional intelligence scores have a relationship with air traffic control operational error rates?

Assumptions

1. From initial training, participants are familiar and know air traffic control procedures and phraseology in accordance to the United States Department of Transportation: Federal Aviation Administration Order 7110.65 Air Traffic Organization Policy.
2. Participants are qualified to know their current emotional/mood state and determine the strength of their current mood state.
3. Participants are capable of evaluating their own stress levels.
4. The study relies on the integrity and honesty of each participant.
5. Participants' scores are graded equally and fairly among the various program course instructors and grading assistants.

Limitations

1. Fewer participants may be acquired due to air traffic control programs consisting of smaller class sizes (approximately 60 students combined in upper level air traffic courses) compared to other typical collegiate level programs.
2. In-depth knowledge and background of the Air Traffic Organization Policy will vary from participant to participant.
3. Varying numbers of positive or negative emotional states may be present.

4. Risk-taking tendencies within individuals will not be considered in the present study.

Purpose of Study

This study will examine air traffic control operational error rates in advanced air traffic control students who self-report their current emotional state before entering into an air traffic control scenario. This will determine if current emotional states have a relationship with decision making processes that can lead to air traffic operational error rates. This study will further investigate whether or not there is a difference between positive and negative emotional states and operational error rates. The study will also look at current participant stress levels and emotional intelligence and operational error rates.

Significance of Study

Former research indicates that both positive and negative emotional states play a role in decision making processes. There currently exists little to no research examining the relationship between emotional states and air traffic controller operational error rates. This study will help further this area of research with the intentions of promoting aviation safety in regard to air traffic controller operations. It will also create further literature along with establishing a basis on which future research can be conducted.

Definitions

- Attitude- A internal feeling or emotion towards a fact or state.
- Affectivity- Relating to, arising from, or influencing feelings or emotions.

- Emotion- An internal state of feeling.
- Mood- A conscious state of mind or predominant emotion.
- Mood Repair- The attempt to improve upon a current emotional state.
- Operational Errors- A resulting failure when attempting to adhere to procedural regulations by an air traffic control specialist as per the Federal Aviation Administration Order 7110.65 Air Traffic Organization Policy.
- Stress- An external factor impacting one's mental and physical well-being.

Literature Review

Previous research indicates that mood, or emotional states, play a role on decision making. Impacts on the quality of decision making due to incidental emotions are something that has been well established in several studies (Andrade & Ariely, 2009; Hockey et al., 2000; Han, Lerner, & Keltner, 2006). Incidental emotions are considered those that are unrelated to the end decision, or unconscious emotional states that an individual is undergoing (Andrade & Ariely, 2009). Organizations have previously asked employees and managers to maintain their affective experiences (experiences that may play a role in an individual's decision making) within a neutral range and to only express their feelings in accordance to defined organizational rules while in the workplace (Seo & Barrett, 2007), therefore having an overall organizational culture of emotional suppression (Pfaff & McNeese, 2010). This suppression is mainly due to an overall viewpoint that stress and emotions can impact decisions and are considered negative from the organizational perspective (Pfaff & McNeese, 2010).

Contrastingly, other organizations have had the belief that feelings may play a role in adaptive decision making (Seo & Barrett, 2007). Adaptive decision making involves individuals experiencing any given emotional state and having the capacity to simultaneously regulate potential biases that may be induced because of these emotional states—a possible positive contribution to overall decision-making performance (Seo & Barrett, 2007). This becomes a problem in the workplace since employees are receiving mixed messages as to how they should act at work due to different organizations maintaining different cultures in regard to how employees are to display or control emotional states.

Literature has traditionally indicated that the intensity of a given emotional state fades away quickly, along with its overall impact on behavior (Andrade & Ariely, 2009). A study conducted by Isen, Clark, & Schwartz (1976) investigated induced positive mood states and the lasting effect of the mood state. It was determined that participants were more likely to be helpful for up to twenty minutes after the manipulation, but at this time, no longer differed from control groups (Isen, Clark, & Schwartz, 1976). This indicates that an emotional state may influence decision making, but typically does not have long lasting effects. Furthermore it has been found that simply informing someone to improve his or her mood typically does nothing beyond a temporary fix (Rooney, 2011), and may not have longer lasting effects.

Since individual emotional states may be a long-term issue, one may want to consider the extent to which decisions are being influenced by emotions (Han, Lerner, & Keltner, 2006), especially in the air traffic control working environment where errors have the potential for significant consequences. Air traffic controllers have been described as intelligent, emotionally stable, and conscientious people who tend to have stable personality factors (Luuk, Luuk, & Aluoja, 2009). Air traffic controllers have also been described as being a "good deal brighter" than the general population, maintained abnormally high levels of detail to their work, and had a very practical approach to work and life (Karson & O'Dell, 1974; Luuk, Luuk, & Aluoja, 2009). These traits are based off of Cattell's Sixteen Personality Factor Questionnaire, in which air traffic controllers proved to be superior over the general population in all sixteen personality factor characteristics (Karson & O'Dell, 1974).

Furthermore, looking at Costa & McCrae's Five-Factor personality model, air traffic controller students were found to have more positive emotional states, higher level of excitement seeking tendencies, and were more conscientious overall when compared to normalized samples (Luuk, Luuk, & Aluoja, 2009). In regard to overall emotional intelligence, this may indicate that air traffic controllers maintain a high level of emotional intelligence than general populations, allowing them to be aware of adverse emotional states.

In aviation and other industries, operator error is frequently cited as a principal failure in time-pressured and hazardous work environments, which can be attributed to high physical and psychological stressors (Pfaff & McNeese, 2010). With air traffic control environments being both time-pressured and potentially hazardous environments, it is important to overcome potential psychological and physical stressors, as well as current emotional states. For an air traffic controller, errors that result in loss of life are psychologically hazardous for controllers and physically hazardous for aircraft and human beings. A general assumption has been that performance is dependent on emotional control and may also be linked to personality traits (Luuk, Luuk, & Aluoja, 2009).

Within the aviation industry, cognitive emotional challenges are a characteristic for the commercial aviation environment (Pfaff & McNeese, 2010), as well as air traffic controllers in their working environment. Essentially, emotional states can (and do) cause decision making to be biased in individuals in several ways (Seo & Barrett, 2007). Some ways that emotional states may influence decision making cognitive processes may include having increased attention, better allocation of working memory, and alternative selection processes (Seo & Barrett, 2007). Motivational implications for decision making processes may also be affected by current emotional states (Seo & Barrett, 2007). Overall emotional intensity, or the magnitude of an emotional state that an individual is experiencing, may also prove to impact decision making processes (Seo & Barrett, 2007).

Decision making and team performance may be impacted due to various mood states in individuals (Greenberg, 2010). One hypothesis put forth by Baron and Russell is that negative emotional states among team members' results in weakened team performance (Pfaff & McNeese, 2010). Individual emotional states (caused by outside factors, i.e. stress) may lead individuals to perform decisions utilizing quicker strategies with reduced accuracy (Pfaff & McNeese, 2010), which may prove to be detrimental in air traffic control. Some reasons for this may be due to reaching a conclusion before seeing all options, considering options in a disorganized manner, or not allowing sufficient time to evaluate each available option (Pfaff & McNeese, 2010). All of which, can cause a breakdown within a group working environment where team members rely upon one another to ensure job duties are properly being carried out.

Currently, there is little research examining the role emotions play in team task performances or their implications to create successful collaborative design systems (Pfaff & McNeese, 2010). Air traffic controllers constantly work in teams and rely on team members to perform at optimal levels, which may be influenced by individual emotional states. People in pleasant affective states have been found to typically have enhanced creativity and performance on complex tasks; people maintaining an unpleasant affective state tend to be more effortful overall, leading to more effective decision making when those decisions require accurate, unbiased, and realistic judgments (Seo & Barrett, 2007). In air traffic control, ensuring correct decision making is essential to maintain a safe and reliable National Airspace System.

Examining how possible individual mood states can influence decision making is essential. Sadness tends to lead an individual to change their actions in order to perhaps seek a desired reward in order to improve upon that mood state (Han, Lerner, & Keltner, 2006). In team scenarios, trends show that members in a sad mood may have an increased chance to devalue or ignore other team member's contributions, leading to an overall decreasing spiral in team performance (Pfaff & McNeese, 2009). This may be extremely detrimental to air traffic control working environments, since this decreasing spiral in performance may have significant effects on aviation safety. Furthermore, negative emotions can have detrimental impacts on task performance within an air traffic controller's working environment (Luuk, Luuk, & Aluoja, 2009). Job performance directly relates to an air traffic controllers ability to maintain positive control over aircraft and ensure that all options are being considered before making a final decision.

Contrastingly, positive mood states have led to safer decision making (risk-aversive behaviors) in higher risk situations (Hockey, Maule, Clough, & Bdzola, 2000). Furthermore, low risk situations have brought on a more adventurous decision making process where success can be seen as more likely (Hockey et al., 2000), perhaps to maintain an overall positive mood. Hockey et al. (2000) investigated the mood regulation model, which states that individuals are going to attempt to maintain positive emotional states and repair negative emotional states. The model plays a role within everyday decisions and within organizational settings. Looking at this model, decision making outcomes may be directed more towards attaining a current mood state rather than acquiring the optimal task solution (Hockey et al., 2000), but remains unclear.

Individuals with high levels of positive affectivity tend to make overall better decisions than individuals with high levels of negative affectivity (Greenberg, 2010). Affectivity can be defined as "relating to, arising from, or influencing feelings or emotions" (Merriam-Webster, 2011). Work groups with a positive mood state also perform more effectively than groups having an overall negative mood state (Greenberg, 2010). Happy mood individuals have also rated themselves and their teammate(s) as having more positive and skilled behaviors and fewer negative, unskilled ones compared to individuals reportedly in a sad mood (Pfaff & McNeese, 2009). Participants emotional states were looked at in a performance pressured environment (similar to air traffic control environments) and it was determined that teams in happy states had higher levels of motivation in this environment and performed better whereas those in a sad state maintained a constant level of performance (Pfaff & McNeese, 2009). Furthermore, there was an overall diminishing team perspective of those in sad state (Pfaff & McNeese, 2009).

The overall success of team cognition is dependent upon shared attitudes among the other team members (Pfaff & McNeese, 2009). Components of shared beliefs that can be interrupted by a single team member in a bad emotional state include team trust, cohesion, and collective efficacy (Pfaff & McNeese, 2009). Individuals working within a team environment also hold beliefs in regard to emotional states they believe are true (Andrade & Ariely, 2009). For example, people tend to maintain the belief that others would act as they would in a similar situation, so if an individual is undergoing a negative emotional state, they believe that others would act the same way when presented with these similar situations (Andrade & Ariely, 2009). This may pose as a potential excuse for individuals undergoing an emotional state impacting their decision making performance.

Another common misbelief is that positive emotional states allow for individuals to have enhanced performance levels, and negative emotional states allow for decreased performance. Performance consists of the processes leading to an outcome for a specific task; performance includes any number of variables and derives from overall errors, properly executed decisions, maintaining procedures, etc. However, it has been argued that negative moods actually promote analytic processing in individuals, thus directing attention towards the source of a particular problem (Hockey et al., 2000). Subjects indicating a sad mood have also performed better, made more efficient use of their memory for task information (compared to a control population) compared to happy moods which made more errors and were able to recall less (Hockey et al., 2000). It is difficult to maintain one perspective over another, due to the fact that the effects of emotions depend on how individual people are capable of handling those emotions during decision making processes (Seo & Barrett, 2007).

Mood Repair

Mood repair is the idea of attempting to improve upon a current emotional state. From a mood repair perspective, individuals experiencing negative moods can be expected to take other options, which often times is taking more risks in comparison to a normalized decision, than they normally would in an attempt to improve upon their current state and obtain a positive outcome (Hockey et al., 2000). Although individuals often consciously attempt to improve upon their current mood state, there can be situations which emotions can impact behavior, which can further outlive the emotion itself (Andrade & Ariely, 2009). Han, Lerner, & Keltner (2006) proposed the Appraisal-Tendency Framework (ATF) as a starting point for distinguishing the effect of emotions on judgments and decision making processes.

The ATF has shown that emotions can influence the judgment of unrelated topics (Han, Lerner, & Keltner, 2006). Individuals have the capability to carryover such emotional states to decision making, even when they are unaware that their subsequent decisions may be influenced (Han, Lerner, & Keltner, 2006). Since decisions may be influenced by emotional states that decision makers are unaware, where there is the possibility of repeating such decisions again in the future (Andrade & Ariely, 2009). “Earlier choices—unconsciously based on a fleeting incidental emotion—can become the basis for future decisions and hence outlive the original cause for the behavior,” or the emotion itself (Andrade & Ariely, 2009, pg. 6). Decisions made while under an emotional experience are capable of not only altering a person’s current decision, but also a future decision, since they rely on their past decisions as a starting point (Andrade & Ariely, 2009).

“Tunnel Vision” Phenomenon

“Tunnel-vision” (formally referred to as channelized attention) may pose as a potential problem when individuals are undergoing a positive or negative mood state. “Tunnel-vision,” or focusing centrally on a task at hand and discounting other tasks, may be problematic for air traffic controllers, especially when controllers may have a large number of aircraft in their airspace. However, currently, it is unclear whether or not emotional states are the source of such potentially unsafe phenomena. Negative moods appear to narrow the attention of individuals to a local focus, thus causing diminished attentiveness to team processes, and hinder problem solving flexibilities (Pfaff & McNeese, 2009).

A study conducted by Gasper and Clore (2002), induced subjects into happy or sad moods to determine if “tunnel vision” became apparent or not. When exposed to problem-solving scenarios, individuals in happy mood states retained higher attention to all aspects of a task compared to the sad moods that remained with their initial strategic approach until interpreting data, when they determined their initial approach became unworkable (Pfaff & McNeese, 2009). This indicates that although individuals in a sad mood state may be more susceptible to “tunnel vision” and will not deviate from their initial strategy early on, they do not completely get stuck into this central focusing point of view. Furthermore, individuals in sad mood states may be able to focus on situations more effectively if the circumstance is correct (Pfaff & McNeese, 2009), but more times than not in air traffic control environments, the circumstance involves maintaining a broader scope of attention to ensure all aircraft are in a safe position.

Stress

Stress factors (external factors to the human impacting one’s state of well-being) often coincide with employee mood states, whether the stress is good or bad, and whether the mood state is good or bad. Stress has the capacity to influence decision making processes in such ways that may either benefit or disrupt an individual decision (Starcke, Wolf, Markowitsch, & Brand, 2008). In many individual and team contexts (including air traffic control), stressors are not simply anticipated, but expected, and are capable of serving as a form of motivation for team members to maintain high levels of performance (Pfaff & McNeese, 2010). On the contrary, stress also has the capability of having a detrimental impact on decision making (Starcke et al., 2008). Individuals under stress learned to process feedback more slowly than non-stressed individuals in regard to selecting disadvantageous choices and selecting more advantageous alternatives (Starcke et al., 2008). Furthermore, the choices were based off of previous decisions made and had to be made with emotional feedback as well (Starcke et al., 2008). Stressors are a constant battle in everyday lives and decision making processes, and can further be enhanced in safety sensitive environments requiring optimum levels of performance.

Neuropsychological studies have examined the impacts stress has on the prefrontal cortex, the part of the brain responsible for such things as memory and executive processing (Starcke et al., 2008). Interestingly, results have indicated an inverted U-shaped relationship between stress levels and memory functions (Starcke et al., 2008). Furthermore, executive functions of the brain have been found to be either normal to enhanced or decreased during times of stress (Starcke et al., 2008). What this indicates is that stress has the capability of either helping or hindering functioning within the brain on a neuropsychological level. During times of decreased functioning, this may prove to be detrimental for aviation professionals.

Psychological stressors are apparent when time pressures exist, as well as threats of negative consequences for poor performance (i.e. allowing two planes to get to close) by an individual (Baradell & Klein, 1993). Due to stressful situations like these, direct effects include an increase in errors on cognitive tasks and tendencies to ignore norms in decision making processes (Baradell & Klein, 1993). This is an essential point for air traffic controllers, since the potential for both time pressure and negative consequences due to poor performance can arise on a daily basis. Naturally occurring stress factors can ultimately have long-term negative consequences on an individual, and adding this to a safety sensitive industry where high levels of stress already exist can further decrease decision making processes (Baradell & Klein, 1993).

Risk-Taking

Risk-taking attitudes are another variable that may go hand-in-hand with emotional states in the workplace. For example, fearful people tend to make pessimistic risk assessments whereas people who are feeling angry tend to do the opposite and make optimistic risk assessments (Han, Lerner, & Keltner, 2006). Depending on an individual's current mood state and environment at hand, risk activity (an individual's susceptibility of choosing riskier or less-risky choices) may be more prone to the effects of emotional states in decision making processes. This makes it difficult to account for, since the level of risk-taking will vary from individual to individual as well as vary within the same individual from time to time. While risk-taking behavior is an important concept to grasp in an

overall air traffic control organizational environment, it may also be considered a personality factor by others and is also beyond the
of the present study.

Summarization

It is apparent that previous literature has mixed reviews on emotional states and decision making processes. However, it is also apparent that emotional states do influence decision making processes. Since the air traffic controller environment depends on controllers to make constant individual decisions on each aircraft they respond to, looking into such a potential issue is necessary. Operational errors performed by air traffic controllers can be measured as a direct result of their decision making capabilities, therefore creating an opportunity for further research to be conducted in regard to air traffic controller emotional states and operational error rates.

CHAPTER II

METHODOLOGY

The purpose of this study is to determine if there is a relationship between self-reported moods and observed air traffic control operational error rates during simulation testing among advanced air traffic control students. Research has been previously conducted investigating mood and the implications on decision making processes. However, research does not exist in determining if mood states have a relationship specifically with air traffic control operational error rates, making this an investigatory study. Further research needs to be conducted to assess whether or not this component of human factors exists or needs to be addressed in the future. The goal of this research is to gain more insight with emotional states and air traffic operational error rates.

The Survey

The surveys will consist of various components including demographics, the Brief Mood Introspection Scale, the Trait Meta-Mood Scale, a perceived stress scale, and overall error rates. The survey will be given to participants before entering the air traffic control scenario and questions will be answered beforehand to ensure accuracy and honesty. Error rates will be determined during air traffic control scenarios. Students will receive the surveys during various class periods with advanced air traffic control class periods being selected as the dataset for the study.

Demographics

Demographic data including gender, age, air traffic control program course, student classification, and completed credit hours in the participant's collegiate career will be used in analysis. Student classification is based upon the total number of credit hours completed.

Brief Mood Introspection Scale (BMIS)

Participants will take the Brief Mood Introspection Scale (BMIS) developed by Mayer and Gaschke (1988). This scale has been used in numerous publications since its development. Participants circle responses on a scale indicating how well each mood describes their current mood state. Responses range from definitely do not feel, do not feel, slightly feel, and definitely feel. Sample moods include happy, sad, grouchy, and nervous. A final question ranging from negative 10 to positive 10 is the participant overall mood state with negative 10 being very unpleasant and positive 10 being very pleasant. This inventory will allow for current mood state to be determined and the strength to which participants view their moods as positive or negative.

Positive and negative moods will also be coded differently to create a means for measurement when comparing to individual error rates. Data will be entered on an individual basis for each participant, but analysis will use the data set as a whole to determine if positive or negative emotional states have a relationship with operational errors.

Participants will be told they are participating in a study that is trying to determine what air traffic control student moods are before entering into an air traffic control scenario to ensure honest answers. Students will not be told their current mood states will be compared against their error rates. Although deception will be used during the study, participants will be told what was actually being sought after data collection is complete. Students will have an additional opportunity to withdraw from the study at this point, but only after they have been informed that their data has been coded and is now unidentifiable to them specifically.

Trait Meta-Mood Scale

The Trait Meta-Mood Scale measures participant emotional intelligence in regard to emotional repair, clarity of experience of feelings, and attention to feelings (Salovey, Mayer, Goldman, Turvey, & Palfai, 1995). Participants rate statements based from 1 (strongly disagree) to 5 (strongly agree). Statements include “I can never tell how I feel” and “I never give into my emotions.” Determining participant emotional intelligence will be used to compare against air traffic error rates to determine if higher emotional intelligence relates to differences in error rates. The test has been utilized in numerous studies since it was developed and support has been found for the construct validity of the emotional management competency that the Trait Meta-Mood Scale assesses (Palmer, Gignac, Bates, & Stough, 2003).

Perceived Stress

The perceived stress measure will measure participant current stress levels from within the last month. The measure is based upon items from Cohen, Kamarck, & Mermelstein’s (1983) global measure of perceived stress.

Participants will answer various questions relating to stress using a scale from 1 (never) to 5 (very often). Questions inquire about the amount that participants have felt nervous and stress or how often they were unable to cope with all the things they had to do.

Error Rates

Error rates will be determined by the amount of points lost from obtaining a perfect scenario score. The error rate score will be the difference between the score achieved by participants and the perfect score of 100 (100% perfect or 0% error rate). Students will be unaware that their error rates will be evaluated against their mood survey. This will be done to ensure honesty of mood and stress responses and that normal operation of the scenario will be conducted without biased performance from participants.

Participant errors are based off of various procedures found within the air traffic control environment and regulations. These criteria for errors may include, but are not limited to, separation minimums, issuing aircraft safety alerts and traffic advisories, phraseology usage, correct procedures adhered to, and positive control of aircraft at all time. Air traffic control associates will be performing the grading of the air traffic control students, all of which have graduated from the air traffic control program, and are current with air traffic procedure.

Participants will be unaware of the errors committed during the scenario until the scenario has been completed in order to avoid any behavior modifications. The observers grading have been trained in air traffic control policies and procedures. No specialized training was conducted for the observers prior to the study. All observers maintained an error detection approach identical to the procedures for training air traffic control students at this level. The participants knew before the performance evaluation the various aspects they would be accountable for during the scenario. No inter-observer bias was determined.

Air Traffic Control Scenario

All participants will undergo equivalent computerized air traffic control scenarios. Equivalent scenarios will have similar aircraft load factors, similar types of aircraft (visual flight aircraft, commercial, and military), and similar air traffic procedural usage. Each scenario last approximately thirty minutes. Students will be evaluated from two separate levels of advanced air traffic control classes, but all participants maintain very similar training despite being from differing class levels.

Air traffic control scenarios consist of various private, commercial, and military aircraft operations consisting of fixed wing and rotary type aircraft. Aircraft are either categorized under VFR (Visual Flight Rules) or IFR (Instrument Flight Rules) flight plans. Both types of flight plans are recognized and are accepted by the Federal Aviation Administration. All positions within the air traffic control scenario are linked (due to air traffic control environments being based upon team settings). Ground, local, terminal, and enroute air traffic controllers are all required to interact with one another to ensure all regulations and procedures are being upheld and aircraft are in positive control.

Participants

Participants will be advanced air traffic control students from a Midwestern university. Advanced air traffic control students classified by credit hours as junior or seniors will be utilized. Participants must be enrolled in advanced air traffic control level classes with junior or senior level status being a prerequisite for enrollment. Advanced air traffic students will be used in order to ensure proper background knowledge of the United States Department of Transportation: Federal Aviation Administration Order 7110.65 Air Traffic Organization Policy. This policy indicates the regulations and phraseology requirements for proper air traffic control procedure, and advanced air traffic control students are required to have background knowledge of these procedures in order to perform in advanced program classes. Furthermore, this will dismiss students who are new to the program and are still in the learning phases of air traffic control procedure, which may play a role in overall operational error rates. The number of desired participants is a minimum of 30 air traffic control students.

Statistical Analysis

This quantitative study will utilize the Statistical Package for Social Sciences (SPSS) to run data analyses. Demographic data will be evaluated and displayed as descriptive statistics. Multiple regression analysis will be utilized to determine if trends exist. Correlational testing will be utilized to determine if relationships exist between current emotional state and operational errors, perceived stress and operational errors, and emotional intelligence and operational errors.

Protection of Human Subjects

All participant data will be reported only as collective data, while individual data will not be reported. The study was reviewed and approved from the Institutional Review Board at the University of North Dakota. Participants had the right to refuse participation in the study, and/or withdraw from the study at any point in time without penalty. The usage of deception was also utilized in this study. Participants were not informed that their survey scores would be compared to air traffic control operational error rates until after the air traffic scenario was completed. It was at this point that the participants were informed that this comparison would occur and were given a secondary consent form. Participants had the right to withdraw from the study at this time, as both consent forms were needed in order to utilize the data collected from participants. All subject data previously collected before voluntary withdrawals was not included in the final data set.

CHAPTER III

RESULTS

Twenty-four advanced air traffic controller student participant completed survey packages were collected (*N=24*). Of the twenty-four responses, the average collegiate year was 3.88. The average total credit hours completed by participants was 113.18 hours. The average age of the participants was 21.88 with the range in age between 19 and 26 years of age. Although both males and females were surveyed, the study resulted in all 24 respondents being male. The 24 advanced air traffic control student operational error rates ranged from 0 to 8. The mean error rate was 3.13 with a median of 2.50.

Table 1: Distribution of Total Number of Air Traffic Control Errors in Scenario

		Frequency	Percent	Valid Percent	Cumulative Percent
Number of ATC Errors	0	2	8.3	8.3	8.3
	1	5	20.8	20.8	29.2
	2	5	20.8	20.8	50.0
	3	4	16.7	16.7	66.7
	4	2	8.3	8.3	75.0
	5	2	8.3	8.3	83.3
	6	1	4.2	4.2	87.5
	8	3	12.5	12.5	100.0
	Total	24	100.0	100.0	

A power analysis was not conducted to determine if the size of the subject pool would yield statistically significant results due to the study initially expecting a limited number of participants. The number of subjects was based upon the number of correctly completed survey packets. Each packet consisted all of the measures used, including operational errors rates and a before and after consent form. If data was incomplete or either consent was not received, then the data was not used for the study. Furthermore, if participants failed to meet requirements of the study the information was not used (i.e. not high enough class level).

The results of this study will be broken down by individual research question.

1. Is there a relationship between self-reported mood and air traffic control error rates in advanced air traffic control students?

Self-reported moods were gathered and grouped together to create four different categories based upon the original study conducted by Mayer & Gaschke (1988). The four categories are pleasant-unpleasant; arousal-calm; positive-tired; and negative-relaxed. The pleasant-unpleasant category dictates participants' as being happy and content on one end and grouchy and sad on the other. The arousal-calm category ranges from aroused and surprised on one end of the scale and quiet and still on the other. The positive-tired category ranges from excited and peppy on one end to sleepy and tired on the other end. The negative-relaxed category ranges from fearful and jittery to relaxed and calm. The pleasant-unpleasant scale ranges from -24 to 24; the arousal-calm scale ranges from 2 to 38; the positive-tired scale ranges from -3 to 18; and the negative-relaxed scale ranges from 1 to 19. An additional overall reported mood was also given by participants. This scale ranged from unpleasant (a value of -10) to pleasant (a value of 10).

Correlational and multiple regression analyses were conducted in order to examine the relationships among air traffic control error rates and the various mood scales as well as the overall indicted mood. Table 2 summarizes the descriptive statistics for each scale while Table 3 summarizes the analysis results.

Table 2: Descriptive Statistics of Mood Scales

	Mean	Std. Deviation	N
Total number of ATC Errors in Scenario	3.13	2.437	24
Pleasant-Unpleasant Score	9.92	5.919	24
Arousal-Calm Score	18.29	3.736	24
Positive-Tired Score	10.29	3.316	24
Negative-Relaxed Score	5.58	3.425	24
Overall Reported Score	7.25	1.847	24

Table 3: Correlations of Mood Scales and Air Traffic Control Error Rates

		Pleasant-Unpleasant Score	Arousal-Calm Score	Positive-Tired Score	Negative-Relaxed Score	Overall Reported Score
Pearson Correlation	Total ATC Errors	.061	.268	.189	.178	.118
Sig. (1-tailed)	Total ATC Errors	.388	.103	.188	.202	.291

The overall multiple regression analysis model with all five variables was not significant: $R^2 = 0.135$, $F(5, 18) = 0.563$, ns. Although the overall model did not reach significance, the effects of each individual emotion on error rates is described below.

Table 4: Coefficients of Mood Scales

	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
Pleasant-Unpleasant Score	.315	.353	.764	.890	.384
Arousal-Calm Score	-.119	.706	-.182	-.168	.868
Positive-Tired Score	-.116	.658	-.158	-.177	.861
Negative-Relaxed Score	.598	.789	.841	.758	.458

Although not statistically significant, increasingly unpleasant moods indicated higher air traffic control error rates: $\beta = .764$, ns. The arousal- calm scale resulted in $\beta = -.182$, ns. Increasingly aroused moods indicated higher error rates. The positive- tired scale resulted in $\beta = -.158$, ns. Increasingly positive (peppy) moods indicated higher error rates. The negative- relaxed score resulted in $\beta = .841$, ns. Increasingly negative moods indicated higher error rates.

Even though none of the individual mood variables reached statistical significance, the magnitude of the beta weights for two of the variables are large enough to suggest that the non-significance is due to inadequate power in the analysis due to the overall small sample size. It is likely that with a larger sample size, greater unpleasant and greater negative moods would have significantly higher levels of air traffic control error rates.

2. Do error rates differ between positive and negative reported moods?

Looking at the data collected, no individuals reported negative moods in the study with a mean of 7.25 on the overall reported mood scale. Therefore, it is unclear whether or not overall positive and negative moods differ in regard to overall operational error rates. The current data set does not represent any negative moods from participant responses making it impossible for a comparison to be completed.

3. Does a relationship exist between participant stress levels and air traffic controller error rates?

The perceived stress scale ranged from 7 to 35 with 7 being little to no stress and 35 being high stress. The mean level of perceived stress was 17.46 indicating that a low to moderate level of stress was present among the collective participant data.

Table 5: Descriptive Statistics of Air Traffic Errors and Perceived Stress

	Mean	Std. Deviation	N
Total number of ATC errors in scenario	3.13	2.437	24
Total Perceived Stress	17.46	3.635	24

Table 6: Correlations of Total Perceived Stress and Error Rates

		Total number of ATC errors in scenario
Total Perceived Stress	Pearson Correlation	.239
	Sig. (2-tailed)	.261
	N	24

Looking at the previous table, there was a non-significant, correlation between total perceived stress and air traffic controller error rates, r = 0.239, N = 24, *p* = 0.261.

4. Do overall emotional intelligence scores have a relationship with air traffic control operational error rates?

The emotional intelligence scale ranged from 30 to 150. A score of 30 indicates that participants need to work on being aware of emotions, 90 indicates that participants have a grasp on their emotions, and 150 indicates participants have an excellent awareness of their emotions. The attained emotional intelligence scores ranged from 86 to 137 with a mean of 114.67. This indicates that the participants' collective data resulted with an above average awareness of their emotional states.

There was a non-significant, correlation between total number of air traffic controller error rates and total emotional intelligence score, $r = 0.143$, $N = 24$, $p = 0.504$.

Table 7: Correlation of Error Rates and Emotional Intelligence Score

		Total emotional intelligence score
Total number of ATC errors in scenario	Pearson Correlation	.143
	Sig. (2-tailed)	.504
	N	24

CHAPTER IV

DISCUSSION

The present data explores the relationships between stress and air traffic error rates, self-reported mood and air traffic error rates, and emotional intelligence and air traffic error rates. This chapter presents a discussion of the results and will conclude with future research implications based off of the current research.

Assumptions

It was assumed that all participants answered the survey questions correctly and honestly. However, participants may have had a bias that kept them from answering truthfully. Other participants were present which may have influenced the way that they view their current stress levels due to not wanting to be an outcast from group norms. Students striving for an air traffic control position may present their conditions to be more positive as well.

Discussion of Results

The total number of participants in this study was 24 participants, resulting in a small sample size. Participants with incomplete survey packages were excluded. Even though both female and male students are enrolled in air traffic control classes, the study consisted of all male participants. The number of potential subjects was dependent on the classes being offered, as well as the number of students to be enrolled within advanced air traffic control classes. The length of the study consisted of only one semester of students. The study consisted of only 24 participants creating a limitation to determine if a relationship exists in the study. Future research should attempt to evaluate a larger subject pool and utilize external resources to obtain higher participant numbers.

Error Rates

Air traffic control operational error rates were committed by 22 of 24 of the participants. Participants did not know their air traffic control operational errors would be compared against stress, mood, and emotional intelligence until the air traffic control scenario was completed. It was at this time the researcher informed them this was the intent of the study and obtained consent for this willing to still participate. The study did involve deception which appeared to benefit the overall cause of the study. Only one participant opted out of participating in the study after being informed of the nature of the project.

It is unclear whether instructor presence influenced air traffic control scores. Since air traffic control is a specialized field following a strict set of rules and regulations, each student is monitored for every decision they make. In real-world air traffic control environments, consistent monitoring is in place therefore this should not be a deviation from normal air traffic environments. With this occurring, the participants may have had higher than normal error rates or lower than normal error rates; these error rates rely upon how well learned the skills being tested are and the workload placed upon the individual participant. It remains unknown due to the collection of a baseline error rate not being conducted.

Stress

It is well documented that stress can impact an individual's decision making processes resulting in decreased capability or higher error rates. The current stress survey indicated that higher levels of total perceived stress indicated higher error rates. It is known that collegiate level students face a large amount of stress while attending school related directly to classwork, financial strains, or other factors. Furthermore, it is expected that participants are going to be having some form of stressors at any given time. The stress measure administered was done so prior to the participation of the simulated air traffic control scenario, and did not account for the stress endured during or due to the scenario.

Due to the small sample size, the perceived stress variable was not statistically significant, but did indicate that higher perceived stress relates to higher air traffic control error rates. The collection of a larger sample size may provide statistically significant results. With the current sample, the participants seemingly are influenced by outside components which impacts decision making skills and capabilities which may include any number of variables such as accuracy, speed, overall confidence, individual capability, etc. This relates directly back to the "tunnel vision" phenomenon research, indicating that those who maintain a higher levels of stress may be more susceptible to having a narrowed field of vision or functioning. Although difficult to assess, “tunnel vision” may be a component from being stressed during the air traffic scenario.

Relating back to Pfaff and McNeese’s (2010) studies, those undergoing stress indicated that participants were more likely to enter into a “tunnel vision” viewpoint. However, it was also indicated that participants were not necessarily stuck in this viewpoint, and had the capacity to disengage from this channelized attention as alternatives were discovered. In this study, air traffic control students that indicated they were stressed prior to the scenario may have similar outcomes. It is unclear if participants are more likely to fall into the “tunnel vision” phenomenon, but if so, they may also be capable of disengaging themselves from this perspective if the scenario is not working in their favor. That is, they may be able to overcome the phenomenon proactively by realizing they are entering it due to falling performance.

Air traffic controllers’ work in a time-pressured environment with high levels of physical and psychological stressors where operational errors are more frequent (Pfaff &McNeese, 2010). However, due to participants also being students within a university setting, it is difficult to determine if the overall perceived stress is based upon the participants knowing they are about to engage in a simulated air traffic control scenario or if it is from other university related stressors. Understanding the true cause of stressors may be an important aspect for future research, especially within a university setting.

Self-Reported Mood

Trends appear to exist when examining the various measures. The arousal- calm scale indicated that increasingly aroused mood related to higher error rates. These aroused moods may be related to stress, nervousness, or other factors, which may be responsible for higher air traffic control error rates. Looking at the negative- relaxed scale, negative moods indicated overall higher error rates. The unpleasant- pleasant scale indicated that increasingly unpleasant moods related to higher air traffic control error rates. These findings verify Baron and Russell's hypothesis that negative states may result in weakened team performance (Pfaff & McNeese, 2010).

Furthermore, this result supports the contrasting literature indicating that a positive mood state leads to safer decision making processes in high risk situations (Hockey et al., 2000), such as air traffic control environments. The result also indicates that better group performance may have been achieved due to the positive mood states (Greenberg, 2010), ultimately leaving the question of whether or not one or a few individuals are capable of influencing an entire air traffic control team.

Emotional Intelligence

The emotional intelligence scores indicated that the participants maintained a higher than average level of being aware of their own emotional states. This supports current literature stating that air traffic controllers score low in empathy traits (Luuk, Luuk, & Aluoja, 2009), allowing them to maintain a higher level of emotional intelligence and being more aware of their own emotional states. In real world air traffic control working environments, emotional intelligence may prove to be beneficial component towards reducing overall human error. However, looking at the regression analysis, it was surprising to find that higher levels of emotional intelligence actually indicated higher air traffic control error rates, creating an opposition to current literature supporting that emotional intelligence may be beneficial for air traffic controllers.

For future studies, emotional intelligence should be considered when determining emotional states since this gives insight about how well an individual is capable of managing a given emotional state. In specific air traffic control training, emotional management strategies may prove to be beneficial for future controllers, since this will allow them to maintain a more desirable emotional state within the workplace so they are potentially capable of maintaining focus, reducing operational errors, and mitigating their changes of entered a perception of channelized vision. However, this remains unclear since the present study related to higher emotional intelligence being related to higher error traffic control error rates. Further research is needed to determine if an employee’s emotional awareness is beneficial or not in maintaining more desirable job performance levels.

Overall Conclusions and Recommendations

Upon completion of the study, several conclusions can be made that can be implemented for future research. The first is in regard to the small sample size. The current study involved advanced air traffic control students at a Midwestern university. Expanding the study to incorporate a larger scale of participants will allow for a more desirable sample size. The usage of deception was anticipated to have decreased participant enrollment, but in this study only one participant opted out of the study after be informed of the deception. In larger scale studies, it may be more difficult to retain participants when deception is utilized.

A second conclusion and recommendation for future studies would be the inclusion of a personality test. Some personalities may typically display differing types of emotional states and may be more capable of dealing with emotions compared to other personality traits. The same can be stated in regard to stress management and risk-taking/ risk-aversion decision making processes. Furthermore, specific types of personalities may actually indicate differing amounts of air traffic operational error rates, a concept that could be incorporated within future research studies to identify relationships that is beyond the scope of this study.

Since air traffic control working environments consist of numerous teams working together, team cohesion is another important aspect to consider. Looking deeper into this topic, it is recommended that integrating how an individual emotional state can change communication patterns, alter leadership styles, or disrupt team interrelations be done. The current study investigates individualized operational error rates in regard to emotional states, stress levels, and emotional intelligence, but understanding how the individual has the capability to disrupt a team working together is just as important.

Conclusively, emotional states go beyond an individual and the operational error rates that he or she conducts. Emotional states may be influenced by external stress, overall emotional intelligence levels, personality traits, or others within a working team environment. Emotional states may also influence risk-taking or risk-aversion behaviors, ultimately changing the numbers of operational errors. The incorporation of all of these variables into a large-scale study may prove to be beneficial by gaining insight to more specific reasons for operational errors as well as be of interest to researchers, air traffic controllers, aviation professionals, or other interested parties.

References

Andrade, E., & Ariely, D. (2009). The enduring impact of transient emotions on decision making. *Organizational Behavior and Human Decision Processes*, *109*, 1-8.

Baradell, J., & Klein, K. (1993). Relationship of life stress and body consciousness to hypervigilant decision making. *Journal of Personality & Social Psychology*, *64*(2), 267-273.

Broach, D., & Dollar, C. U.S. Department of Transportation, Federal Aviation Administration. (2002). *Relationship of employee attitudes and supervisor-controller ratio to en route operational error rates*. Washington, DC: Office of Aerospace Medicine.

Eid, M., Shneider, C., & Schwenkmezger, P. (1999). Do you feel better or worse? the validity of perceived deviations of mood states from mood traits. *European Journal of Personality*, *13*, 283-306.

Federal Aviation Administration. (2007). *FAA long-range aerospace forecasts fiscal years 2020, 2025, and 2030.* Washington, D.C.: Retrieved from http://www.faa.gov/about/office_org/headquarters_offices/apl/aviation_forecasts/long-range_forecasts/media/long07.pdf.

Federal Aviation Administration, Office of Aerospace Medicine. (2011). *Studies of next generation air traffic control specialists: Why be an air traffic controller?* Washington, D.C.: Retrieved from http://www.faa.gov/library/reports/medical/oamtechreports/2010s/media/201112.pdf.

Gasper, K., & Clore, G. (2002). Attending to the big picture: Mood and global versus local processing of visual information. *Psychological Science*, *13*(1), 34-40.

Greenberg, J. (2010). *Managing behavior in organizations*. (Fifth ed.). Upper Saddle River, NJ: Pearson Education, Inc.

Han, S., Lerner, J, & Keltner, D. (2006). Feelings and consumer decision making: The appraisal-tendency framework. *Journal of Consumer Psychology*.

Hockey, G., Maule, A., Clough, P., & Bdzola, L. (2000). Effects of negative mood states on risk in everyday decision making. *Cognition and Emotion*, *14*(6), 823-855.

Karson, S. & O'Dell, J. (1974). Personality makeup of the american air traffic controller. *Aerospace Medicine, 45*, 1001-1007.

Isen, A., Clark, M., & Schwartz, M. (1976). Duration of the effect of good mood on helping: Footprints on the sanes of time. *Journal of Personality and Social Psychology, 34,* 385-393.

Luuk, K., Luuk, A., & Aluoja, A. (2009). Predicting professional success of air traffic control personnel from their personality profile at admission to ab initio training. *International Journal of Aviation Psychology*, *19*(3), 235-251.

Mayer, J., & Gaschke, Y. (1988). The experience and meta-experience of mood. *Journal of Personality and Social Psychology*, *55*, 102-111.

Merriam-webster dictionary. (2011). Retrieved from http://www.merriam-webster.com.

Palmer, B., Gignac, G., Bates, T., & Stough, C. (2003). Examining the structure of the trait meta-mood scale. *Australian Journal of Psychology*, *55*(3), 154-158.

Pfaff, M., & McNeese, M. (2010). Effects of mood and stress on distributed team cognition. *Theoretical Issues in Ergonomics Science*, *11*(4), 321-339.

Reason, J. (1990). *Human error*. New York, NY: Cambridge University Press.

Reason, J. (1997). *Managing the risks of organizational accidents*. Burlington, VT: Ashgate Publishing Company.

Reason, J. (2008). *The human contribution*. Burlington, VT: Ashgate Publishing Company.

Rooney, J. (2011). Shaping human performance. *The Journal for Quality & Participation*, *34*(2), 37-40.

Salovey, P., Mayer, J. D., Goldman, S. L., Turvey, C., & Palfai, T. P. (1995). Emotional attention, clarity, and repair: Exploring emotional intelligence using the Trait Meta-Mood Scale. *Emotion, Disclosure, and Health*,*125*, 154.

Schroeder, D., Bailey, L., Pounds, J., & Manning, C. (2006). Federal Aviation Administration, Civil Aerospace Medical Institute. *A human factors review of the operational error literature*. Washington D.C.,: Retrieved from website: http://www.dtic.mil/cgi-bin/GetTRDoc?AD=ADA461408.

Seo, M., & Barrett, L. (2007). Being emotional during decision making-good or bad? An empirical investigation. *Academy of Management Journal*, *50*(4), 923-940.

Starcke, K., Wolf, O. T., Markowitsch, H. J., & Brand, M. (2008). Anticipatory Stress Influences Decision Making Under Explicit Risk Conditions. *Behavioral Neuroscience*, *122*(6), 1352-1360.

Torres, K., Metscher, D., & Smith, M. (2011). A correlational study of the relationship between human factor errors and the occurrence of runway incursions. *International Journal of Professional Aviation Training & Testing Research*, *5*(1), 3-25.

U.S. Department of Labor, Bureau of Labor Statistics. (2009). *Occupational outlook handbook: 2010-11 Edition- Air Traffic Controllers*. Retrieved from http://www.bls.gov/oco/pdf/ocos108.pdf.

U.S. Department of Transportation, Federal Aviation Administration. (2004). *Advisory circular: crew resource management training* Retrieved from http://rgl.faa.gov/Regulatory_and_Guidance_Library/rgAdvisoryCircular.nsf/list/AC 120-51E/$FILE/AC120-51e.pdf.

Wiegmann, D., & Shappell, S. (2003). *A human error approach to aviation accident analysis*. Burlington, VT: Ashgate Publishing Company.